CITY OF LONG BEACH STORM WATER MONITORING REPORT 2001-2002

NPDES PERMIT NO.
CAS004003 (CI 8052)

JULY 2002

SUBMITTED BY

CITY
OF
LONG
BEACH

PREPARED BY

KINNETIC LABORATORIES, INC.
AND
SOUTHERN CALIFORNIA COASTAL
WATER RESEARCH PROJECT

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ACRONYMNS AND ABBREVIATIONS LIST

ASTM - American Society for Testing and Materials
BHC - Benzene hexachloride
BMP - Best Management Practice
BOD- Biological Oxygen Demand
CCC – Criterion Continuous Concentration
CD - Compact Disk
CFU - Colony Forming Units
CMC – Criterion Maximum Concentration
COD - Chemical Oxygen Demand
CTR - California Toxics Rule
CV - Coefficient of Variance
2,4 D - 2,4-dichlorophenoxy
2,4 DB - (2,4-dichlorophenoxy) butanoic acid
DDD - dichloro (p-chlorophenyl)ethane
DDE - dichloro (p-chlorophenyl)ethylene
DDT - dichlorodiphenyl trichloroethane
DF - dilution factor
DI - Deionized
DL - Detection Limit (considered the same as RL)
DO - Dissolved Oxygen
EC_{50} - Concentration causing effects to 50% of the test population
EDTA - ethylene diamine triacetic acid
EMC- Event mean concentration
GIS - Geographic Information System
IC25 - Concentration causing 25% inhibition in growth or reproduction
IC50 - Concentration causing 50% inhibition in growth or reproduction
ICP-MS - Inductively Coupled Plasma-Mass Spectrometry
ID - Identifier
ID - Insufficient Data
KLASS - Kinnetic Laboratories Automated Sampling System
KLI - Kinnetic Laboratories, Inc.
LC_{50} - Bioassay concentration that produces 50% lethality
LDPE - Low Density Polyethylene
LOEC - Lowest Observed Effect Concentration
LPC - Limiting Permissible Concentration
MBAS - methylene-blue-active substances
MCPA - 2-methyl-4-chloro-phenoxy acetic acid
MCPP - 2-(4-chloro-2-methylphenoxy) propanoic acid
ML – Minimum level as defined in State Implementation Plan
MPN- Most Probable Number
MS4 - Multiple Separate Storm Sewer System
MTBE- Methyl Tertiary Butyl Ether
NCDC-National Climate Data Center
NPDES –National Pollutant Discharge Elimination System
NOEC - No observed effect concentration
NTS - Not to Scale
NTU - nephelometric turbidity units
NURP- Nationwide Urban Runoff Program

PAH - Polynuclear Aromatic Hydrocarbons
PCB - Polychlorinated bi-phenyls
PDF - Portable Document Format
ppb - Parts per Billion
Q - Flow
QA/QC - Quality Assurance/Quality Control
RBF- RBF Consultants
RMP - Regional Monitoring Program
RL- Reporting Limit (considered the same as DL)
RPD- Relative Percent Difference
SAP - Sampling and Analysis Plan
SCCWRP - Southern California Coastal Water Research Project
sf- Square Feet
SIP – State Implementation Plan
SM- Standard Methods for the Examination of Water and Wastewater
SOP - Standard Operating Procedure
SRM - Standard Reference Material
STS - sodium tetradecyl sulfate
SV - Semi-Volatile Compound
2, 4, 5-TP - 2-(2,4,5-trichlorophenoxy) propanoic acid
2, 4, 5-T - 2,4,5-trichlorophenoxy
TBD - To Be Determined
TDS – Total Dissolved Solids
TIE – Toxicity Identification Evaluation
TKN- Total Kjeldahl Nitrogen
TOC - Total Organic Carbons
2, 4, 5-TP - 2-(2,4,5-trichlorophenoxy) propanoic acid
TPH - total petroleum hydrocarbons
TRPH - Total Recoverable Petroleum Hydrocarbons
TSI - ToxScan, Inc.
TSS –Total Suspended Solids
TTLC - Total Threshold Limit Concentration
TU - Toxicity Unit
TUc – Chronic Toxicity Unit
USEPA - U.S. Environmental Protection Agency
WQO - Water Quality Objective
WQS - Water Quality Standard

CITY OF LONG BEACH
STORMWATER MONITORING REPORT 2001/2002

NPDES Permit No. CAS004003 (CI 8052)

1.0 EXECUTIVE SUMMARY

1.1 Background and Purpose

The City of Long Beach is required to conduct a water quality monitoring program for stormwater and dry weather discharges through the City's municipal separate storm sewer system (MS4). The water quality monitoring program beginning in the 1999/2000 wet weather season under terms of Order No. 99-060 National Pollutant Discharge Elimination Systems Municipal Permit No. CAS004003 (CI 8052).

The monitoring program calls for monitoring mass emissions and toxicity at three representative mass emission sites during the first wet season and four sites for subsequent wet seasons. Four wet weather storm events were to be monitored annually. Monitoring of one receiving water site (Alamitos Bay) was also required for each of these four wet weather storm events. In addition, dry weather inspections and the collection and analysis of dry weather discharges were required at each of these monitoring sites over two different 24-hour periods during each dry season. Water samples collected at the monitoring sites during each time period were to be analyzed for all parameters specified in the permit and tested for toxicity. Additionally, the program called for monitoring the receiving water body site (Alamitos Bay) for bacteria and toxicity to provide water quality information during both the wet and dry seasons, and on the effectiveness of a dry-weather diversion.

Monitoring sites specified in the permit are as follows:

- Basin 14: Dominguez Gap Pump Station Monitoring Site
- Basin 20: Bouton Creek Monitoring Site
- Basin 23: Belmont Pump Station Monitoring Site
- Basin 27: Los Cerritos Channel Monitoring Site (Second Year)
- Alamitos Bay Receiving Water Monitoring Site

During the first 1999/2000 wet weather season, start-up delays associated with permitting for placement of stormwater monitoring equipment in the Los Angeles County Flood Control District facilities prevented the wet weather monitoring from being carried out. Instead, a special research study on Parking Lot Runoff was carried out with the permission of the Regional Water Quality Control Board staff. In addition, the required dry weather monitoring was carried out for this first year. The first annual report (Kinnetic Laboratories, Inc., 2000) covered the first season dry-weather monitoring events performed in June of 2000 as well as one additional receiving water sampling in April 2000. The second annual report (Kinnetic Laboratories, Inc., 2001) covered a full season of wet season and dry season monitoring. This report also presented and interpreted the data obtained by the program up to that point in time. In addition to the dry weather sampling, four wet weather events were monitored at each of the monitoring sites, with the exception of the Dominguez Gap Pump Station where rainfall was insufficient, causing a discharge for only three events.

The purpose of this present report is to submit the results of the City of Long Beach's stormwater monitoring program for the third year, 2001/2002. Kinnetic Laboratories, Inc. conducted this monitoring program as Prime Contractor to the City of Long Beach. Analytical laboratory services were provided by

ToxScan, Inc. supplemented by other participating laboratories as necessary. Toxicity studies, including Toxicity Identification Evaluations (TIEs) were also conducted by ToxScan, Inc. Interpretation of the toxicity and TIE data was performed by the Southern California Coastal Water Research Project (SCCWRP) as a subcontractor to Kinnetic Laboratories. In the previous year, SCCWRP staff had performed the marine toxicity tests but, due to laboratory loads, these tests were performed by ToxScan this year.

1.2 Summary of Results

Rainfall and Sampling Events

All monitoring stations were fully operational at the start of the 2001/2002 wet weather season and precipitation and discharge were continuously monitored throughout the season. Record low rainfall occurred during this 2001/2002 wet season. Furthermore, most of this rain occurred before January. These factors limited the number of successful stormwater monitoring events captured during the year in spite of numerous false event attempts. Precipitation during the 2001/2002 water year was 84% below normal in Long Beach, amounting to only 1.99 inches of rain recorded by the National Weather Service climate station at Long Beach Airport, compared to a normal year of 12.27 inches and 13.32 inches last year.

Importantly, however, the first two storm events of the 2001/2002 season were captured at three of the stations (Belmont Pump Station, Los Cerritos Creek, and Bouton Creek), though rainfall was insufficient to cause a discharge at the Dominguez Gap Pump Station. Both were relatively small events characterized by brief, intense periods of scattered shower activity. Total rainfall during each event at the three stations ranged between 0.23 to 0.39 inches which did represent a significant percentage of the total rainfall for the season.

Dry weather inspections/monitoring events were obtained in August, 2001 and in May 2002 for the three mass-emission sites, Dominguez Gap Pump Station, Bouton Creek, and the Belmont Pump Station, as well as for Alamitos Bay. Again, the Dominguez Pump Station inflow was dry during these inspections. An additional dry weather event will be carried out at all of these sites later this summer (August, 2002).

The results of the City of Long Beach's stormwater monitoring program may be briefly summarized as follows based upon the data for the monitored events available at this time for the program.

Chemical and Bacterial Results

- Currently, numerical standards do not exist for stormwater discharges. However, water quality criteria or objectives may provide reference points for assessing the relative importance of various stormwater contaminants, though specific receiving water studies are necessary to quantify the presence and magnitude of any actual water quality impacts.

- For reference only, provisional water quality benchmarks are developed and presented herein based upon work in the Central Valley Regional Water Quality Control Board (Marshack, 2000) and draft benchmarks under development as part of Project Clean Water in San Diego County.

- Event Mean Concentrations (EMCs) calculated for contaminants in Long Beach stormwater discharges were compared with the water quality benchmarks appropriate to the designated beneficial uses of the Long Beach receiving waters.

- Oil and grease (O&G) exceeded by 2 to 2.5 times benchmark values based upon USEPA's Stormwater Multisector General Permit for Industrial Activities (O&G; 15, mg/l) for the Belmont Pump Station and the Los Cerritos Channel.

- Total suspended solids (TSS) in the Long Beach wet weather discharges exceeded by 5 to 10 times the draft benchmarks (TSS; 60-100 mg/l) based upon the median EMC from the National Urban Runoff Program (USEPA, 1983b).

- Concentrations of bacteria (total coliform, fecal coliform, and enterococcus) in the Long Beach stormwater discharges were high compared to benchmark values based upon receiving water criteria, as is common for all urban runoff. Mean EMCs for fecal coliform were highest at the Belmont Pump Station where stormwater is discharged directly to Alamitos Bay. Mean values in the Long Beach stormwater discharges are three orders of magnitude greater than the benchmark values. Other studies have shown however that such exceedances are not limited to urban stormwater sources but are also measured from undeveloped surrounding land.

- For the Alamitos Bay receiving water, samples from this study for all three years and from the City of Long Beach Department of Health and Human Services monitoring data were compared with historical rainfall records from the Long Beach Airport. Microbiological data from the City's stormwater program demonstrate relatively low levels of total coliform, fecal coliform, and fecal streptococcus during all dry weather periods. Based upon dry weather data obtained before a dry season interceptor was instatalled in Basin 24 as compared to dry season data after that time, it is not apparent that the interceptor has had any discernable impact on the bacterial concentrations in Alamitos Bay during the extended dry weather during the summer of 2000. Tests conducted during wet weather periods resulted in levels of each bacterial component that were one to two orders of magnitude higher than during summer dry weather periods.

- Benchmark values used for trace metals were mostly based upon Criteria Maximum Concentrations (CMC) values form the California Toxics Rule (USEPA, 2000). Only two metals were found to exceed benchmark values in the Long Beach stormwater discharges, and in both cases, only the estuarine/marine benchmarks were exceeded. The mean EMC for copper at the Belmont Pump Station was approximately three times the benchmark value for discharges to enclosed bays and estuaries. Mean copper EMCs for discharges to inland surface waters were below the benchmark value of 13 ug/l. The mean EMC for dissolved zinc at the Belmont Pump Station was 98 ug/l, slightly exceeding the enclosed bay and estuary benchmark value of 90 ug/l. Mean EMCs for dissolved zinc at both Bouton Creek and Los Cerritos were 78-84 ug./, which was approximately 2/3 of the inland surface water benchmark.

- Benchmark values for organic compounds for both saltwater and freshwater were based upon recent assessments conducted by the California Department of Fish and Game (Seipmann and Finlayson, 2002). Diazinon benchmarks are routinely exceeded in discharges from the Belmont Pump, Bouton Creek, and the Los Cerritos Channel. Mean EMCs for the two monitoring sites that discharge to inland surface waters were roughly four to five times higher than the proposed benchmark, while discharges from the Belmont Pump station was an order of magnitude greater than the marine/estuarine benchmark. Chlorpyrifos, another organophosphate pesticide, was found in significant concentration in water from the second storm event in the Los Cerritos Channel, approximately one order of magnitude greater than the recently updated California Department of Fish and Game benchmark. Other organic compounds are rarely detected in the stormwater samples, and when detected, are often very near reporting limits. Glyphosate, which was detected in runoff the previous year was not detected in runoff from any of the sites during the 2001/2002 season. Low levels of two organochlorine pesticides DDT and aldrin were present in a few samples during the past monitoring year. Phthalate compounds are common in the stormwater samples but are present at relatively low levels. The highest concentration reported for a phthalate compound (bis(2)ethylhexylphthalate) this season was 10 ug/l. Both diazinon and chlorpyrifos are undergoing changes in registration due to the high toxicities as well as persistent occurrences in runoff, and their uses may be curtailed or phased out.

- Noteworthy findings from the dry weather sampling are as follows:
  - Chemical results generally did not tend to vary greatly between sites or sampling dates, and with a few exceptions, contaminant concentrations were consistent with previous results and no parameters stood out as particularly high.
  - Diazinon was the only organic contaminant routinely detected in the dry weather discharges this year due to lower detection limits. The herbicide 2, 4-D, was absent from all sites in the fall survey but was present in all samples from the May survey. Several phthalate compounds were detected in the August 2001 surveys but were below detection limits in the May 2002 surveys.
  - Dry weather discharges were typically low in suspended solids and total metals, but dissolved metals were more consistent with the expected dissolved/total ratios than those measured during wet weather events. Dissolved metals occurred at levels similar to those measured during the winter storm events. Increased hardness during the dry weather conditions tends to mitigate potential toxicity.
  - Elevated pH levels are common in excess of 9.0 probably due to high benthic algal production resulting in low levels of CO_2 and concurrent high levels of dissolved oxygen and lower alkalinity.
  - Bouton Creek dry weather discharge shows higher specific conductivities, COD, chloride, and TDS as saltwater continues to drain form the algal turf well after low tide, along with low dry weather flows.
  - Dry level flows continue to show moderately high levels of bacteria including total and fecal coliform as well as enterococci, with total and fecal coliform above benchmark levels. The effects of these flows are not typically evident in receiving water as demonstrated both by concurrent measurements form Alamitos Bay and surveys conducted by the City's Department of Health as discussed in this report.
  - Discharges to and from the Dominguez Gap Pump Station continue to be dry during the dry weather season.

Toxicity Results

- Toxicity was detected for each of the three stations sampled this year for each of the two wet weather storm events, which was consistent with the results from last year's monitoring. The toxicity measured was greater this year, possibly because these were the first flush storms of the year, in contrast to the later storms monitored last year. The frequency and magnitude of stormwater toxicity from the Long Beach stations is similar to stormwater samples from other southern California watersheds, with Chollas Creek (San Diego) and Ballona Creek (Santa Monica) most similar to the Long Beach study, as these samples were obtained from smaller highly urbanized watersheds relative to the Los Angeles River and San Gabriel River.

- Consistent with last year's results, toxicity was measured in all of the dry weather samples, but was again less than that measured in the wet weather samples. These results are indicative of significant differences in the composition of stormwater and dry weather discharge form the City of Long Beach.

- No significant toxicity was present in any of the Alamitos Bay receiving water samples as was true last year. These results are consistent with three dry weather samples collected from the same site in 2000. Salinity measurements indicated that the wet weather receiving water samples contained about 2 % or less fresh water. The lack of toxicity in the Alamitos Bay samples is consistent with the results of the wet weather discharge samples, which usually had NOEC values greater than 5-10%.

- The modified TIE trigger criteria instituted this year facilitated a successful TIE testing program, with 12 wet weather and 2 dry weather TIEs attempted that yielded useful information on 10 samples. The results of this year were consistent within each species and similar to the data obtained from the previous year.

- All TIEs conducted using the water flea indicated that organophosphate pesticides were the most likely category of toxic constituents.

- The two-year toxicity data also implicated dissolved metals, particularly zinc and copper as causes of stormwater toxicity. These conclusions are supported by the TIE results, by correlations of toxicity with chemical constituents, and by calculations of predicted toxicity based upon measured zinc and copper concentrations in the stormwater.

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2.0 INTRODUCTION

The City of Long Beach received an NPDES Permit issued by the California Regional Water Quality Control Board, Los Angeles Region on 30 June 1999 (Order No 99-060, NPDES No. CAS004003, (CI 8052)). This order defines Waste Discharge Requirements for Municipal Stormwater and Urban Runoff discharges within the City of Long Beach. Specifically, the permit regulates discharges of stormwater and urban runoff from municipal separate storm sewer systems (MS4s), also called storm drain systems, into receiving waters of the Los Angeles Basin.

The Regional Board modified the permit by letter on October 24, 2001 based upon review of the second year report and concurrent modifications being negotiated on the Los Angeles County stormwater permit. Permit modifications consisted of three primary elements. The first modification was an adjustment to the list of constituents and the required reporting limits for consistency with Minimum Levels (MLs) listed in the State's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays and Estuaries of California* (2000). The second change addressed the requirements for triggering TIEs and a reduction in toxicity testing requirements for the mysid, *Americamysis*. TIE triggers were changed to enhance opportunities for defining toxicity that might be related to first flush or other early season events. The final change was a requirement to compare stormwater quality data to water quality criteria applicable to specific beneficial uses in each receiving water body.

The City of Long Beach serves a population of about 462,000 people in an area of approximately 50 square miles. The discharges from the MS4 system consist of surface runoff (non-stormwater and stormwater) from various land uses in the hydrologic drainage basins within the City. Approximately 44% of the land area discharges to the Los Angeles River, 7% to the San Gabriel River, and the remaining 49% drains directly to Long Beach Harbor and San Pedro Bay (City of Long Beach Municipal Stormwater Permit, 1999). The quality and quantity of these discharges vary considerably and are affected by the hydrology, geology, and land use characteristics of the watersheds; seasonal weather patterns; and frequency and duration of storm events. Impairments or threatened impairments of beneficial uses of water bodies in Long Beach include Alamitos Bay, Los Angeles River, El Dorado Lake, Los Angeles River Reach 1 and Reach 2, San Gabriel River Estuary, San Gabriel River Reach 1, Colorado Lagoon, and Los Cerritos Channel. These areas also include coastal shorelines, including Alamitos Bay Beaches, Belmont shore Beach, Bluff Park Beach, and Long Beach Shore.

The NPDES permit requires the City of Long Beach to prepare, maintain, and update if necessary a monitoring plan. The specified monitoring plan requires the City to monitor three discharge sites (Year 1) and four discharge sites (Years 2 through 5) draining representative urban watersheds (mass emission sites) during the first two years of the monitoring program. Flow, chemical analysis of water quality, and toxicity are to be monitored at each of these sites for four representative storm events each year. During the dry season, inspections and monitoring of these same discharge sites are to be carried out, with the same water quality characterization and toxicity tests to be run. In addition, one receiving water body (Alamitos Bay) is to be monitored for bacteria and toxicity during both the wet and the dry seasons and the effect of a dry weather diversion documented. In years three through five of the permit period, the City was also expected to participate in a "fair share" study of receiving waters in the Los Angeles River and San Gabriel River watersheds. The Regional Board has verbally indicated that this effort is being eliminated or delayed.

The purpose of this present report is to submit the results of the City of Long Beach's stormwater monitoring program for the third year, 2001/2002.

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3.0 STUDY AREA DESCRIPTION

The four sites for mass emissions monitoring were originally selected by the City of Long Beach with the assistance of the Southern California Coastal Water Research Project (SCCWRP), with input from the environmental community, the Los Angeles County Deparment of Public Works and with the approval of the Regional Water Quality Control Board. These sites were then specified in the NPDES permit after an analysis of the drainage basins and receiving waters. They were selected to be representative of the stormwater discharges from the City's storm drain system, as well as to be practical sites to carry out stormwater and dry weather monitoring. An additional site in Alamitos Bay was also selected as representative of receiving waters and for evaluation of the effectiveness of a dry weather diversion.

3.1 Regional Setting

3.1.1 Geography

The City of Long Beach is located in the center and southern part of the Los Angeles Basin (Figure 3.1) and is part of the highly urbanized Los Angeles region. In addition to residential and other uses, the City also encompasses heavy industrial and commercial areas and includes a major port facility, one of the largest in the United States. The City's waterfront is protected from the open Pacific Ocean by the extensive rock dikes encircling the outer harbor area of the Port of Los Angeles/Port of Long Beach complex. The waterfront includes port facilities along with a downtown commercial/residential area that includes small boat marinas, recreational areas, and convention facilities. Topography within the City boundaries can be generally characterized as low relief, with Signal Hill being the most prominent topographic feature (Figure 3.2).

3.1.2 Major Watersheds

Major water bodies receiving stormwater discharges from the City of Long Beach include the Los Angeles River located near the western boundary of the City, the San Gabriel River located near the eastern boundary, and the outer Harbor of the Los Angeles/Long Beach area. The City of Long Beach has fifteen pump stations that discharge into the Los Angeles River, and one pump station that discharges into the San Gabriel River. Receiving water sub-areas of importance include the extensive Alamitos Bay, heavily developed for marina and recreational uses, and the inner harbor areas of the City, heavily developed as port facilities. Other receiving water sub-areas include the Los Angeles River, El Dorado Lake, Los Angeles River Reach 1 and Reach 2, San Gabriel River Estuary, San Gabriel River Reach 1, Colorado Lagoon, and Los Cerritos Channel. These areas also include coastal shorelines, including Alamitos Bay Beaches, Belmont shore Beach, Bluff Park Beach, and Long Beach Shore. The drainage from the City is characterized by major creeks or storm channels, usually diked and/or concrete lined such as the Los Cerritos Channel that originates in Long Beach, flows near the eastern City boundary, and discharges into the Marine Stadium and then into Alamitos Bay. Other such regional drains include:

- Coyote Creek, which passes through a small portion of Long Beach before it discharges to the San Gabriel River;
- Heather Channel and Los Cerritos Line E that both enter Long Beach from the City of Lakewood and discharge into the Los Cerritos Channel; and the
- Artesia-Norwalk Drain that enters Long Beach from Hawaiian Gardens and discharges into Coyote Creek.

The City of Long Beach is divided into 30 watersheds as shown in Figure 3.3. Data presently in the City of Long Beach GIS database on total areas and specific land use categories for each basin are given in

Table 3.1 (City of Long Beach 2001). Specific watersheds selected by the City of Long Beach for this present stormwater monitoring program are described in more detail in the following section.

3.1.3 Annual Rainfall and Climate

The City of Long Beach is located in the semi-arid Southern California coastal area and receives significant rainfall on a seasonal basis. The rain season generally extends from October through April, with the heavier rains more likely in the months of November through March (see Figure 5.1 for average rainfall by month and seasonal total rainfall as measured at the Long Beach Airport). Total average annual rainfall at the Long Beach Airport is 12 inches per year.

The City lies in the Los Angeles Plain, which is south of the Santa Monica and San Gabriel Mountains and west of the San Jose and the Puente Hills. The Los Angeles River is the largest stream on the plain and it drains the San Fernando Valley and much of the San Gabriel Mountains. Most of the streams are dry during the summer and there are no lakes or ponds, other than temporary ponding behind dunes (Miles & Goudy, 1998). The climate is mild, with a 30-year average temperature of 23.4 °C (74.1°F) at the Long Beach Daugherty Airport (NCDC, 2000).

3.1.4 Population and Land Use Characteristics

The population of the City of Long Beach totaled 461,522 residents during the year 2000 (U.S. Census Bureau, 2000). The total population of the County of Los Angeles, in which it resides, was 9,519,338. The independent city of Signal Hill, located on a promontory, is surrounded by the City of Long Beach. Signal Hill's population numbered 9,333 in the year 2000 and it contributes runoff to drainage basins 6, 7, 8, 9 and 18.

The City of Long Beach has a total area of 26,616 acres. Of that total 16,926 acres (64%) are classified as residential, 4,784 acres (18%) as commercial, 2,269 acres (8.5%) as industrial, 1,846 (7%) as institutional, and 786 acres (3%) as open space (City of Long Beach, 1999). The drainage basins sampled for the stormwater monitoring study follow this general pattern of land use.

Figure 3.1. **Los Angeles Basin. (Source: 3-D TopoQuads Copyright 1999 DelLorme, Yarmouth, ME 04096).**

Figure 3.2. **City of Long Beach. (Source: 3-D TopoQuads Copyright 1999 DelLorme, Yarmouth, ME 04096).**

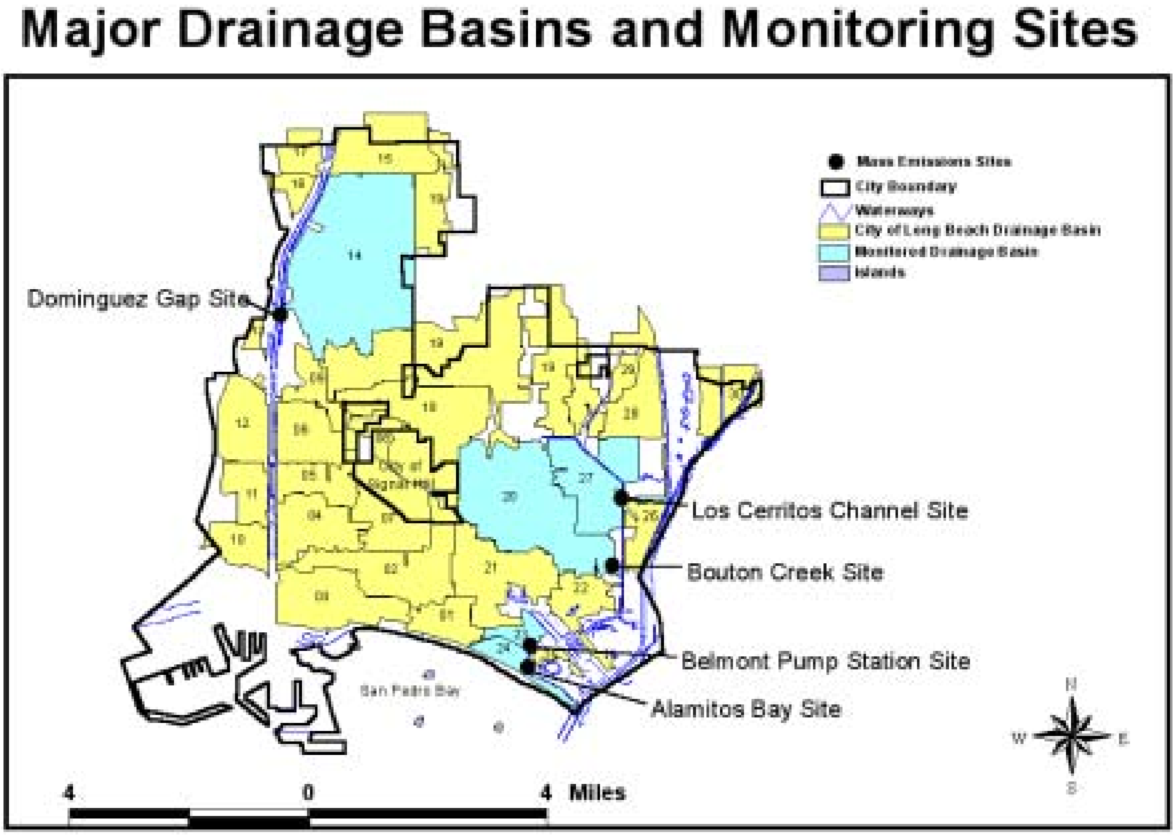

Figure 3.3. City of Long Beach Major Drainage Basins (Source: City of Long Beach, Department of Technology Services) and City of Long Beach Stormwater Monitoring Sites.

Table 3.1. Total Areas and Land Use for City of Long Beach Watersheds.

Drainage Basin	Drainage Pattern	Sub-basins	Total Acres	Residential Acres	Commercial Acres	Industrial Acres	Institutional Acres	Open Space Acres
1	N to S	4	456	393	44	0	7	12
2	E to W	1	1,276	905	287	22	59	3
3	E to W	3	1,083	367	642	7	58	9
4	E to W	2	810	426	176	140	56	12
5	E to W	1	546	434	97	0	13	2
6	S & SE	1	695	475	125	0	73	17
7	to center	1	1,029	858	89	11	53	18
8	E to W	1	248	163	27	58	0	0
9	SW & NW	1	399	295	91	0	12	1
10	S & E	3	416	16	49	351	0	0
11	S & E	1	424	338	64	3	18	1
12	S & E	1	719	556	98	9	41	15
13	S & E	1	84	0	7	77	0	0
14	S & W	2	3,374	2,445	392	148	273	116
15	S & W	1	958	569	167	197	25	0
16	N to S	1	194	113	61	8	5	7
17	S & E	1	317	244	68	0	5	0
18	E	1	1,814	804	262	729	19	0
19	E	20	3,898	2,475	610	439	228	146
20	S & E	1	2,259	1,215	412	70	492	70
21	S & E	3	1,172	773	125	0	55	219
22	variable	9	520	38	428	0	54	0
23	S	1	213	110	85	0	14	4
24	SE & NW	1	281	188	30	0	0	63
25	W & E	2	90	70	9	0	4	7
26	S & W	3	355	304	22	0	29	0
27	E & S	9	1,083	825	109	0	143	6
28	S & E	1	630	386	179	0	65	0
29	S	8	727	633	10	0	26	58
30	SW(6) & SE(1)	7	546	508	19	0	19	0
		Total Acres	26,616	16,926	4,784	2,269	1,846	786

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4.0 MONITORING PROGRAM

4.1. Monitoring Program Objectives

The stated long-term objectives of the stormwater monitoring program (Part 3, II, A(1-6)) are as follows:

1. Estimate annual mass emissions of pollutants discharged to surface waters through the MS4;
2. Evaluate water column and sediment toxicity in receiving waters;
3. Evaluate impact of stormwater/urban runoff on biological species in receiving waters;
4. Determine and prioritize pollutants of concern in stormwater;
5. Identify pollutant sources on the basis of flow sampling, facility inspections, and ICID investigations; and
6. Evaluate BMP effectiveness.

The emphasis during the first two years of monitoring efforts has been directed towards characterizing the chemical and toxicological characteristics of discharges from the city's MS4 during both storm events and dry weather periods to develop the data needed to address the first five objectives listed above. In addition, a start on BMP investigations through the special Parking Lot Study was implemented during the first full year of monitoring. Specific objectives of this year's work included the following:

1. Obtain monitoring data from four (4) storm events for each mass emission station during the 2001/2002 storm season along with corresponding receiving water sampling at the Alamitos Bay receiving water station.
2. Carry out dry weather inspections and obtain samples of dry weather flow at each of the four mass emission stations and the receiving water station. Perform this dry weather work twice during the dry season that extends from May through October.
3. Perform chemical analyses for the specified suite of analytes at the appropriate detection limits for all stormwater samples collected.
4. Perform toxicity testing of the stormwater samples collected, and Toxicity Identification Evaluations (TIEs) if warranted by the toxicity results at a given site.
5. Report the above results and evaluate the monitoring data with respect to receiving water quality criteria.

4.2 Monitoring Site Descriptions

4.2.1 Basin 14: Dominguez Gap Monitoring Site

A sampling station located at the Dominguez Gap Pump Station is intended to monitor Basin 14 that covers 3,374 acres. Land use in this basin is 72% residential, 12% commercial, 8% institutional, 4% industrial, and 4% open space (Figure 4.1). The basin is located in the northwestern portion of Long Beach just east of the Los Angeles River and is bounded on the north, south, east, and west by Artesia Boulevard, Roosevelt Road, the railroad, and the Los Angeles River respectively (City of Long Beach, 2001). The location of the Dominguez Gap Pump Station is shown in Figure 4.2 with the coordinates given in Table 4.1. Photographs of the site are shown in Figure 4.3.

Normally in the summer, the retention basin located adjacent to the pump station would be dry according to the Flood Maintenance Division of the Los Angeles County of Public Works. However, current practice is to have the pumps locked off for the summer with water diverted into the retention basin from the Los Angeles River to recharge the groundwater aquifer and to study the feasibility of a wetland habitat in the area. During winter storms, the retention basin fills from stormwater discharge, which then infiltrates into the groundwater. During intense rains, when the retention basin fills to a specified level, the pump station pumps the water over the levee and discharges it into the Los Angeles River.

The stormwater monitoring equipment is located within the Dominguez Gap Pump Station. The automatic sampler utilized a peristaltic pump to collect water from the pump station's sump. The sampler was activated at the same set point (sump elevation) that activated the main discharge pumps, thus obtaining water samples during discharge to the Los Angeles River. Sump elevation was determined with a pressure transducer. Flow rates were determined from the individual pump curves of each pump, and total volume discharged was obtained by integrating this data over the period of time each pump discharged.

4.2.2 Basin 20: Bouton Creek Monitoring Site

This site collects water from Basin 20 covering 2,259 acres. Basin 20 is 54% residential, 22% institutional, 18% commercial, 3% industrial, and 3% open space (Figure 4.4). This basin is located in the east central portion of the City and is bounded on the north, south, east, and west by Spring Street, 8th Avenue, the Los Cerritos Channel and Redondo Avenue, respectively. The sampling station is located a short way upstream from the point of discharge into Los Cerritos Channel, along side of the Alamitos Maintenance Yard of the Los Angeles County Public Works Department. The location of the sampling station is shown in Figure 4.5 and Table 4.1. Photographs of the site are shown in Figure 4.6.

At the sampling station, Bouton Creek is a 35 ft wide, 8.5 ft deep open concrete box channel. The elevation of the channel bed is approximately one inch lower at the side than the center. About a quarter of a mile to the southeast, Bouton Creek flows into Los Cerritos Channel. Based on numerous observations of conductivity at various tides, this site has saltwater influence at tide levels above three feet. The automatic sampling equipment was therefore configured and programmed to measure discharge flow and to obtain flow composited samples of the freshwater discharge down the creek, avoiding the tidal contributions by using real-time conductivity sensors. A velocity sensor was mounted on the invert of the box channel near the center of flow. Two conductivity sensors were mounted on the wall of the channel near the bottom and 2 feet above the bottom. A third conductivity sensor and the sample intake were mounted on a floating arm that kept them near the surface. In practice, the horizontal boundary between brackish tidal water and fresh stormwater was found to be fairly sharp, allowing good separation for sampling and volume measurements of the stormwater discharge.

4.2.3 Basin 23: Belmont Pump Station Monitoring Site

This site collects water from Basin 23 that covers 213 acres. Land use in the basin is 52% residential, 40% commercial, 0% industrial, 6% institutional, and 2% open space (Figure 4.7). This basin is located in the southeastern portion of the City and is bounded on the north, south, east, and west by Colorado Street, Division Street, Ultimo Avenue and Belmont Avenue respectively. The Belmont Pump Station is located at 222 Claremont Avenue as shown in Figure 4.8 with coordinates given in Table 4.1. Photographs of this site are shown in Figure 4.9.

Water enters the forebay of the facility via a nine-foot diameter underground storm pipe. A trash rack catches debris before water drops four feet into the sump area. A single sump pump typically comes on and discharges about two feet of water from the sump area every evening at around 2300 hours. Four main pumps are available to remove water during storm events. Water from these pumps is discharged into Alamitos Bay.

The stormwater monitoring equipment was located outside the pump station but on the grounds of the pump station inside a steel utility box. The sensors and sampling hose were installed inside the pump station sump adjacent to the large discharge pumps. The automatic sampler utilized a peristaltic pump to sample from the sump. The sampler was activated at the same set point (sump elevation) that activated the discharge pumps, thus obtaining water samples during the discharge to Alamitos Bay. Sump elevation was determined with a pressure transducer. Flow rates were determined from the individual pump curves of each pump, and total volume discharged (obtained by integrating this data over the period of time each pump discharged).

4.2.4 Basin 27: Los Cerritos Channel Monitoring Site

Basin 27 is 1,083 acres and land use is 76% residential, 10% commercial, 13% institutional, and 1% open space (Figure 4.10). It is located in the east central portion of Long Beach and is bound on the north, south, east, and west by Spring Street, Rendina Street, the San Gabriel River, and Bellflower Boulevard, respectively.

The drainage pattern is to the east and south on the west side of the Los Cerritos Channel and to the west and south on the east side. There are eight major storm drain systems with a total of three major storm drain lines contributing runoff. All eight major systems discharge into the Los Cerritos Channel.

The stormwater monitoring station was installed in a steel utility box located on the west side of the channel south of Stearns Street. The site location and coordinates are shown in Figure 4.11 and in Table 4.1. Photographs of the site are shown in Figure 4.12. Flow sensors and sampling tubing was installed on the bottom of the large concrete lined channel. This sampling site is above tidewater on Los Cerritos Channel. Flow rates based upon flow velocity and channel dimensions are used to control the composite sampler, and to calculate total flow at the end of the storm event.

4.2.5 Alamitos Bay Receiving Water Monitoring Site

Alamitos Bay, located along the southeastern shoreline of Long Beach, is an extensive inshore estuarine area opening to the waters of the Outer Harbor. It supports extensive marina and recreational uses as well as residential/commercial uses in nearby areas. It also receives stormwater runoff from the Los Cerritos Channel and local drainage basins.

The Bayshore Aquatic Park on the southwestern shore of Alamitos Bay was selected and designated in the permit to be the receiving water site for this stormwater monitoring study. This site is downstream of the monitoring sites for Basins 20 and 23 but also receives stormwater from other basins as well. The monitoring site selected was at the end of a floating wharf located approximately 41 meters 188 degrees true north of the Alamitos Bay Pump Station outfall (Figure 3.3, Table 4.1). The end of the outfall pipe to Alamitos Bay is elevated above the surface of the water of the Bay. Grab samples were taken at the end of the dock during an in-coming tide for bacteria and toxicity only.

The Alamitos Bay Pump Station discharges stormwater from Basin 24 (Figure 4.13). Basin 24 consists of 281 acres located along the south shore of Alamitos Bay and westward along the shore of the Outer Harbor. Land use in Basin 24 consists of 67% residential, 11% commercial, and 22% open space with no industrial or institutional land use (Figure 4.13). The site location and coordinates are shown in Figure 4.14 and in Table 4.1. Photographs of the site are shown in Figure 4.15. A dry-weather storm drain diversion project was constructed in the fall of 1999 for Basin 24. This diversion was activated May 1, 2000 to divert dry weather flows to the sanitary system. The results from monitoring this site were also intended to help in the assessment of the effectiveness of this dry weather diversion.

4.3 Monitoring Station Design and Configuration

Each of the four land use stations monitored in Long Beach were equipped with a Kinnetic Laboratories Automatic Sampling System (KLASS). Figure 4.16 illustrates the configuration of a typical KLASS. This system consists of several commercially available components that Kinnetic Laboratories has integrated and programmed into an efficient flow-based stormwater compositing sampler. The receiving water site was not equipped with a KLASS.

The integral components of this system consist of an acoustic Doppler flow meter or a pressure transducer, a data logger/controller module, cellular or landline telecommunications equipment, a rain gauge, and a peristaltic sampler. The system installed at Bouton Creek also incorporated several conductivity cells for distinguishing tidal flow from fresh water runoff.

The equipment was installed with intakes and sensors securely mounted, tubing and wires in conduits, and all above ground instruments protected within a security enclosure. Section 4.2 described how the equipment was placed at each station.

All materials used in the collection and handling of stormwater samples met strict criteria in order to prevent any form of contamination of the sample. These materials must allow both inorganic and organic trace toxicant analyses from the same sampler and composite bottle. Only the highest grade of borosilicate glass is suitable for both trace metal and organic analyses from the same composite sample bottle. Sample hoses were Teflon®.

All bottles and hoses were cleaned according to EPA-approved protocols consistent with approved methodology for analysis of stormwater samples (USEPA, 1983a). These bottles and hoses were then evaluated through a blanking process to verify that the hoses and composite bottles were contamination-free and appropriately cleaned for analyses of both inorganic and organic constituents.

4.4 Field Monitoring Procedures

4.4.1 Wet Weather Monitoring

4.4.1.1 Composite Sample Collection

A priority objective of the storm monitoring is to maximize the percent storm capture of the composite sample, while ensuring that the composite bottle collects enough water to support all the required analyses. This study required volumes of up to 70 liters of sample from each of the four land use sites to meet these analytical needs.

All aspects of the sampling events were continuously tracked from an office command and control center (Storm Control) located at our Santa Cruz laboratory. The status of each station is monitored through telecommunication links to each site. Station data were downloaded, and the stations were controlled and reprogrammed remotely. Weather information, including Doppler displays of rainfall for each area being monitored were also available on screen at the Storm Control center. In addition, Storm Control is in contact by cellular phone with the field crews.

When a storm is likely, all stations are made ready to sample. This preparation included entering the correct volume of runoff required for each sample aliquot ("Volume to Sample"), setting the automatic sampler and the data logger to sampling mode, pre-icing the composite sample bottle, and performing a general equipment inspection. A brief physical inspection of the equipment was made (if possible) to make certain that there were no obvious problems such as broken conduit, a kinked hose, or debris.

Once a storm event ended, the stations were shut down either on site or remotely by Storm Control. The station was left ready for the next storm event in case there was insufficient time for a maintenance visit between storms. Data were retrieved remotely via telecommunications from the data logger on a daily basis throughout the wet weather season.

All water samples were kept chilled (4ºC) and were transferred to the analytical laboratories within holding times. Prior to sample shipping, sub-sampling from the composite container into sample containers was accomplished using protocol cleaned Teflon and silicone sub-sampling hoses and a peristaltic pump. Using a large magnetic stirrer, all composite water was first mixed together thoroughly and then continuously mixed while the sub-sampling took place. All sub-sampling took place at a staging area near Long Beach. Documentation accompanying samples to the laboratories included Chain of Custody forms, and Analysis Request forms (complete with detection limits).

4.4.1.2 Grab Sampling

During each storm event, grab samples for oil and grease, total recoverable petroleum hydrocarbons (TRPH), total and fecal coliform, enterococcus, and methyl tertiary butyl ether (MTBE) were collected. The timing of grab sampling efforts was often driven by the short holding times for the bacterial analyses. The ability to deliver samples to the microbiological laboratory within the 6-hour holding time was always a major consideration.

Except at the pump stations, all grab samples were taken near the center of flow as possible or at least in an area of sufficient velocity to ensure good mixing. At the Dominguez Gap sampling site, grabs were taken from the sump. At the Belmont pump station, grabs were taken at the point of discharge for the pumps. Some sites required the use of a pole to obtain the samples. Poles used were fitted with special bottle holders to secure the sampling containers. Care was taken not to overfill the sample containers as some of the containers contained preservative. For the MTBE samples, care was taken to assure that no air bubbles were trapped in the sample vial.

4.4.2 Dry Weather Sampling

The Citiy's NPDES Permit calls for two dry weather inspections and sampling events to be carried out during the summer dry weather period at each of the four mass emission stations as well as samples to be taken at the Alamitos Bay receiving water site.

Inspections at each site included whether water was present and whether this water was flowing or just ponded. At sites that were found not to have flowing water, inspections were done in the upstream drains to verify that flow was not occurring into the site. This situation was encountered again this year at the Dominguez Gap Pump station where remnants of water were still ponded in the basin in front of the pump station, but the storm drain discharges into this basin were dry.

When flowing water was present at one of these mass emission sites, then water quality measurements, flow estimates, and water samples were taken along with observations of site conditions. Flowing water was present and all measurements were taken at Bouton Creek, the Belmont Pump Station, and at Los

Cerritos Channel. Temperature and conductivity were measured with an Orion Model 140 meter, pH with an Orion Model 250 meter, and oxygen was measured with an Orion Model 840 meter.

Water samples were collected at the Belmont Pump Station and the Los Cerritos Channel Station by use of an automatic peristaltic pump sampler that collected aliquots every half hour for a 24-hour period. For the Bouton Creek Station where tidal influences are present, a similar sample was collected over a 2-4 hour period of low tide in order to sample just the fresh water discharge down the creek. Additional grab samples were taken just after the time-composited samples for MTBE, TPH, and bacteria. All samples were chilled to 4 ^{0}C and transported to the appropriate laboratory for analysis.

4.5 Laboratory Analyses

The water quality constituents selected for this program were established based upon the requirements of the City of Long Beach NPDES permit for stormwater discharges. Analytical methods are based upon approved USEPA methodology. Substantial changes were made to the analytical suite and certain detection limits based upon extensive discussions with Regional Board staff. The most significant changes were elimination of many of the herbicides, carbamate and urea pesticides that were below reporting limits in both this and the Los Angeles County monitoring efforts. Other significant changes included reduction of reporting limits for metals, organophosphates, chlorinated pesticides and semivolatile organic compounds. The following sections detail laboratory methods for chemical and biological testing.

4.5.1 Analytical Suite and Methods

Conventional, bacteriological, and chemical constituents selected for inclusion in this stormwater quality program are presented in Table 4.2. Analytical method numbers, holding times, and reporting limits are also indicated for each analysis.

4.5.1.1 Laboratory QA/QC

Quality Assurance/ Quality Control (QA/QC) activities associated with laboratory analyses are detailed in Appendix A.

The laboratory QA/QC activities provide information needed to assess potential laboratory contamination, analytical precision and accuracy, and representativeness. Analytical quality assurance for this program included the following:

- Employing analytical chemists trained in the procedures to be followed.
- Adherence to documented procedures, USEPA methods and written SOPs.
- Calibration of analytical instruments.
- Use of quality control samples, internal standards, surrogates and SRMs.
- Complete documentation of sample tracking and analysis.

Internal laboratory quality control checks included the use of internal standards, method blanks, matrix spike/spike duplicates, duplicates, laboratory control spikes and Standard Reference Materials (SRMs).

Data validation was performed in accordance with the National Functional Guidelines for Organic Data Review (EPA540/R-94/012), Inorganic Data Review (EPA540/R-94/013), and Guidance on the Documentation and Evaluation of Trace Metals Data Collected for the Clean Water Act Compliance Monitoring (EPA/821/B/95/002).

4.5.2 Toxicity Testing Procedures

Upon receipt in the laboratory, stormwater discharge and receiving water samples were stored at 4 °C, in the dark until used in toxicity testing. Toxicity testing commenced within 72 hours of sample collection for most samples. The relative toxicity of each discharge sample was evaluated using three chronic test methods: the water flea (*Ceriodaphnia dubia*) reproduction and survival test (freshwater), the purple sea urchin (*Strongylocentrotus purpuratus*) fertilization test (marine), and the mysid (*Americamysis bahia*) growth and survival test (marine). Each of the methods is recommended by the USEPA for the measurement of effluent and receiving water toxicity. Samples of marine receiving water from Alamitos Bay were tested with the two marine species only. Water samples were diluted with laboratory water to produce a concentration series using procedures specific to each test method.

4.5.2.1 Water Flea Reproduction and Survival Test

Toxicity tests using the water flea, *Ceriodaphnia dubia*, were conducted in accordance with methods recommended by USEPA (1994a). The test procedure consisted of exposing 10 *C. dubia* neonates (less than 24 hours old) to the samples for six days. One animal was placed in each of 10 individual polystyrene cups containing approximately 20 mL of test solution. The test temperature was 25 ± 1 °C and the photoperiod was 16 hours light: 8 hours dark. Daily water changes were accomplished by transferring each individual to a fresh cup of test solution; water quality measurements and observations of survival and reproduction (number of offspring) were made at this time also. Prior to transfer, each cup was inoculated with food (100 µL of a 3:1 mixture of *Selenastrum* culture, density approximately 3.5 x 10^8 cells/mL, and *Ceriodaphnia* chow).

The test organisms were obtained from in-house cultures that were established from broodstock obtained from USEPA (Duluth, MN). The laboratory water used for cultures, controls, and preparation of sample dilutions was synthetic moderately hard freshwater, prepared with deionized water and reagent chemicals. Test samples were poured through a 60 µm Nitex screen in order to remove indigenous organisms prior to preparation of the test concentrations. Serial dilutions of the test sample were prepared, resulting in test concentrations of 100, 50, 25, 12, and 6 %.

The quality assurance program for this test consisted of three components. First, a control sample (laboratory water) was included in all tests in order to document the health of the test organisms. Second, a reference toxicant test consisting of a concentration series of potassium chloride (KCl) was conducted with each batch of samples to evaluate test sensitivity and precision. Third, the results were compared to established performance criteria for control survival, reproduction, reference toxicant sensitivity, sample storage, and test conditions. Any deviations from the performance criteria were noted in the laboratory records and prompted corrective action, ranging from a repeat of the test to adjustment of laboratory equipment.

4.5.2.2 Mysid Growth and Survival Test

Samples of wet weather discharge and receiving water were assessed for chronic toxicity using the marine mysid, *Americamysis bahia* (formerly named *Mysidopsis bahia*). Test procedures followed the guidelines established by USEPA (1994b). The procedure consisted of a seven-day exposure of juvenile (7 day old) mysids to the samples. Eight replicate test chambers (250 mL beakers), each containing five mysids, were tested for each concentration. The beakers contained 150 mL of test solution, which was changed daily. The test temperature was 26 ± 1 °C and the photoperiod was 16 hours light: 8 hours dark. Water quality and mysid survival measurements were recorded during each water change. Mysids were fed a standardized amount of newly hatched brine shrimp twice daily. At the end of the test, the surviving animals were dried and weighed to the nearest 0.001 mg to determine effects on growth.

The discharge water samples were adjusted to a salinity of 30 g/kg before testing. This was accomplished by adding a sea salt mixture (TropicMarin™) to the samples. The addition of sea salts was carried out the day before a test was initiated. The receiving water samples from Alamitos Bay had salinities greater than 30 g/kg and were tested without adjustment of the salinity. The salinity-adjusted samples were then diluted with seawater to produce test concentrations of 100, 50, 25, 12, and 6%. The test organisms were lab-reared *A. bahia* that were purchased from a commercial supplier. For most of the tests, the animals were received the day before the test started and were acclimated to the test temperature and salinity overnight.

Negative control (1.0 µm and activated carbon filtered natural seawater from ToxScan's Marine Bioassay facility at Long Marine Laboratory in Santa Cruz was diluted to 30 g/kg with deionized water) and sea salt control samples (deionized water mixed with sea salts) were included in each test series for quality control purposes. In addition, a reference toxicant test was included with each batch of test samples. Each reference toxicant test consisted of a concentration series of copper chloride with eight replicates tested per concentration. The median lethal concentration (LC50) was calculated from the data and compared to control limits based upon the cumulative mean and two standard deviations from recent experiments. Control and water quality data were also compared to established performance objectives; any deviations from these were noted and corrected, if possible.

4.5.2.3 Sea Urchin Fertilization Test

All discharge and receiving water samples of stormwater were also evaluated for toxicity using the purple sea urchin fertilization test (USEPA 1995b). This test measures toxic effects on sea urchin sperm, which are expressed as a reduction in their ability to fertilize eggs. The test consisted of a 20-minute exposure of sperm to the samples. Eggs were then added and given 20 minutes for fertilization to occur. The eggs were then preserved and examined later with a microscope to assess the percentage of successful fertilization. Toxic effects are expressed as a reduction in fertilization percentage. Purple sea urchins (*Strongylocentrotus purpuratus*) used in the tests were supplied by U.C. Davis – Granite Canyon. The tests were conducted in glass shell vials containing 10 mL of solution at a temperature of 15 ± 1 °C. Five replicates were tested at each sample concentration.

All samples were adjusted to a salinity of 33.5 g/kg for the fertilization test. Previous experience has determined that many sea salt mixes are toxic to sea urchin sperm. Therefore, the salinity for the urchin test was adjusted by the addition of hypersaline brine. The brine was prepared by freezing and partially thawing seawater. Since the addition of brine dilutes the sample, the highest stormwater concentration that could be tested for the sperm cell test was 50%. The adjusted samples were diluted with seawater to produce test concentrations of 50, 25, 12, 6, and 3%.

Seawater control (1.0 µm filtered natural seawater from ToxScan's Long Marine Laboratory facility) and brine control samples (50% deionized water and 50% brine) were included in each test series for quality control purposes. Water quality parameters (temperature, dissolved oxygen, pH, ammonia, and salinity) were measured on the test samples to ensure that the experimental conditions were within desired ranges and did not create unintended stress on the test organisms. In addition, a reference toxicant test was included with each stormwater test series in order to document intralaboratory variability. Each reference toxicant test consisted of a concentration series of copper sulfate with four replicates tested per concentration. The median effective concentration (EC50) was estimated from the data and compared to control limits based upon the cumulative mean and two standard deviations of recent experiments.

4.5.2.4 Toxicity Identification Evaluations (TIEs)

Phase I TIEs were conducted on selected runoff samples from stations that exhibited substantial (≥ 2 TU_{ec}) toxicity, in order to determine the characteristics of the toxicants present. Each sample was subjected to treatments designed to selectively remove or neutralize classes of compounds (e.g., metals, nonpolar organics) and thus the toxicity that may be associated with them. Treated samples were then tested to determine the change in toxicity using the sea urchin fertilization test.

Four or five treatments were applied to each sample. These treatments were: particle removal, trace metal chelation, nonpolar organic extraction, organophosphate (OP) deactivation (except urchins) and chemical reduction. With the exception of the organics extraction, each treatment was applied independently on a salinity-adjusted sample. A control sample (lab dilution water) was included with each type of treatment to verify that the manipulation itself was not causing toxicity. If the TIE was not conducted concurrently with the initial testing of a sample, then a reduced set of concentrations of untreated sample was tested at the time of the TIE to determine the baseline toxicity and control for changes in toxicity due to sample storage.

Ethylene diamine tetraacetic acid (EDTA), a chelator of metals, was added to a concentration of 60 mg/L to the marine test samples. EDTA additions to the *Ceriodaphnia* samples were based upon sample hardness (USEPA 1991). Sodium thiosulfate (STS), a treatment that reduces oxidants such as chlorine and also decreases the toxicity of some metals was added to a concentration of 50 mg/L to separate portions of each marine sample. STS additions to the *Ceriodaphnia* samples were at 500, 250 and 125 mg/L. The EDTA and sodium thiosulfate treatments were given at least one hour to interact with the sample prior to the start of toxicity testing. Pipernyl butoxide, which inhibits activation of OP pesticides was added to a concentration of 100 mg/L for mysids and at three concentrations (125, 250 and 500 mg/L) for *Ceriodaphnia.*

Samples were centrifuged for 30 min at 3000 X g to remove particle-borne contaminants and tested for toxicity. A portion of the centrifuged sample was also passed through a 360 mg Sep-Pak™ C-18 solid phase extraction column in order to remove nonpolar organic compounds. C-18 columns have also been found to remove some metals from aqueous solutions.

4.5.2.5 Statistical Analysis

The toxicity test results were normalized to the control response in order to facilitate comparisons of toxicity between experiments. Normalization was accomplished by expressing the test responses as a percentage of the control value. Four statistical parameters (NOEC, LOEC, median effect, and TUc) were calculated to describe the magnitude of stormwater toxicity. The NOEC (highest test concentration not producing a statistically significant reduction in fertilization or survival) and LOEC (lowest test concentration producing a statistically significant reduction in fertilization or survival) were calculated by comparing the response at each concentration to the dilution water control. Various statistical tests were used to make this comparison, depending upon the characteristics of the data. Water flea survival and reproduction data were usually tested against the control using Fisher's Exact and Steel's Many-One Rank test, respectively. Sea urchin fertilization and mysid survival data were evaluated for significant differences using Dunnett's multiple comparison test, provided that the data met criteria for homogeneity of variance and normal distribution. Data that did not meet these criteria were analyzed by the non-parametric Steel's Many-One Rank or Wilcoxon's tests.

Measures of median effect for each test were calculated as the LC50 (concentration producing a 50% reduction in survival) for mysid and water flea survival, the EC50 (concentration effective on 50% of eggs) for sea urchin fertilization, or the IC50 (concentration inhibitory to 50% of individuals) for water flea reproduction and IC25 for mysid growth. The LC50 or EC50 was calculated using either probit analysis or the trimmed Spearman-Karber method. The IC25 and IC50 were calculated using linear interpolation analysis. All procedures for calculation of median effects followed USEPA guidelines.

The toxicity results were also expressed as chronic Toxic Units (TUc). This statistic was calculated as: 100/NOEC. Increased values of toxic units indicate relatively greater toxicity, whereas greater toxicity for the NOEC, LOEC, and median effect statistics is indicated by a lower value.

Comparisons of chemical or physical parameters with toxicity results were made using the non-parametric Spearman rank order correlation.

Table 4.1 Location Coordinates of Monitoring Stations for the City of Long Beach Stormwater Monitoring Program.

Station Name	State Plane Coordinates: Zone 5		North American Datum (NAD) 83	
	Northing (ft)	**Easting (ft)**	**Latitude**	**Longitude**
Belmont Pump	1734834.9	6522091.2	33° 45' 36.6"N	118° 07' 48.7"W
Bouton Creek	1741960.5	6529305.2	33° 46' 44.3"N	118° 06' 23.4"W
Los Cerritos Channel	1747935.9	6530153.2	33° 47' 43.3"N	118° 06'13.4"W
Dominguez Gap	1764025.0	6500042.5	33° 50' 22.1"N	118° 12' 10.5"W
Alamitos Bay (Floating Dock)	1732942.2	6521892.8	33° 45' 15.0"N	118° 07' 52.0"W
Alamitos Bay (Dry-Weather Outfall)	1732807.4	6521874.4	33° 45' 13.7"N	118° 07' 54.2"W

Table 4.2. Analytical Methods, Holding Times, and Reporting Limits.

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit
CONVENTIONAL PARAMETERS			
Oil and Grease (mg/L)	1664	28 days	5.0
Total Phenols (mg/L)	420.1	28 days	0.1
Cyanide (µg/L)	335.2	14 days	0.005
pH (units)	150.1	ASAP	0 – 14
Dissolved Phosphorus (mg/L)	365.3	48 hours	0.05
Total Phosphorus (mg/L)	365.3	28 days	0.05
Turbidity (NTU)	180.1	48 hours	0.1
Total Suspended Solids (mg/L)	160.2	7 days	1.0
Total Dissolved Solids (mg/L)	160.1	7 days	1.0
Volatile Suspended Solids (mg/L)	160.4	7 days	2.0
Total Organic Carbon (mg/L)	415.1	28 days	1.0
Total Recoverable Petroleum Hydrocarbon (mg/L)	1664	28 days	5.0
Biochemical Oxygen Demand (mg/L)	405.1	48 hours	2.0
Chemical Oxygen Demand (mg/L)	410.1	28 days	10
Total Ammonia-Nitrogen (mg/L)	350.2	28 days	0.1
Total Kjeldahl Nitrogen (mg/L)	351.3	28 days	0.1
Nitrite Nitrogen (mg/L)	300.0	48 hours	0.1
Nitrate Nitrogen (mg/L)	300.0	48 hours	0.1
Alkalinity, as CaCO3 (mg/L)	310.1	48 hours	2.0
Specific Conductance (umhos/cm)	120.1	48 hours	1.0
Total Hardness (mg/L)	130.2	180 days	2.0
MBAS (mg/L)	425.1	48 hours	0.5
Chloride (mg/L)	300.0	48 hours	2.0
Fluoride (mg/L)	300.0	48 hours	0.1
Methyl tertiary butyl ether (MTBE) (µg/L)	8020A	14 days	1.0
BACTERIA (MPN/100ml)			
Total Coliform	SM 9221B	6 hours	<20
Fecal Coliform	SM 9221B	6 hours	<20
Enterococcus	SM 9230C	6 hours	<20
TOTAL AND DISSOLVED METALS (µg/L)[1]			
Aluminum	200.8	180 days	100
Antimony	200.8	180 days	0.5
Arsenic	200.8	180 days	1.0
Beryllium	200.8	180 days	0.5
Cadmium	200.8	180 days	0.25
Chromium	200.8	180 days	0.5
Copper	200.8	180 days	0.5
Hexavalent Chromium (total)	SM 3500D	24 hours	5.0
Iron	236.1	180 days	100
Lead	200.8	180 days	0.5
Mercury	245.1	28 days	0.5
Nickel	200.8	180 days	1.0
Selenium	200.8	180 days	1.0
Silver	200.8	180 days	0.25
Thallium	200.8	180 days	1.0
Zinc	200.8	180 days	1.0

1. Samples to be analyzed for dissolved metals are to be filtered within 48 hours.

Table 4.2. Analytical Methods, Holding Times, and Reporting Limits. (continued)

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit
CHLORINATED PESTICIDES (µg/L)			
Aldrin	8081A	7 days	0.005
alpha-BHC	8081A	7 days	0.01
beta-BHC	8081A	7 days	0.005
delta-BHC	8081A	7 days	0.005
gamma-BHC (lindane)	8081A	7 days	0.02
alpha-Chlordane	8081A	7 days	0.1
gamma-Chlordane	8081A	7 days	0.1
4,4'-DDD	8081A	7 days	0.05
4,4'-DDE	8081A	7 days	0.05
4,4'-DDT	8081A	7 days	0.01
Dieldrin	8081A	7 days	0.01
Endosulfan I	8081A	7 days	0.02
Endosulfan II	8081A	7 days	0.01
Endosulfan sulfate	8081A	7 days	0.05
Endrin	8081A	7 days	0.01
Endrin Aldehyde	8081A	7 days	0.01
Heptachlor	8081A	7 days	0.01
Heptachlor Epoxide	8081A	7 days	0.01
Toxaphene	8081A	7 days	0.5
Total PCBs	8081A	7 days	1.0
AROCLORS (µg/L)			
Aroclor-1016	8081A	7 days	0.5
Aroclor-1221	8081A	7 days	0.5
Aroclor-1232	8081A	7 days	0.5
Aroclor-1242	8081A	7 days	0.5
Aroclor-1248	8081A	7 days	0.5
Aroclor-1254	8081A	7 days	0.5
Aroclor-1260	8081A	7 days	0.5
ORGANOPHOSPHATE PESTICIDES (µg/L)			
Diazinon	8141A	7 days	0.01
Chlorpyrifos (Dursban)	8141A	7 days	0.5
Malathion	8141A	7 days	1.0
Prometryn	8141A	7 days	2.0
Atrazine	8141A	7 days	2.0
Simazine	8141A	7 days	2.0
Cyanazine	8141A	7 days	2.0
HERBICIDES (µg/L)			
2,4-D	8151A	7 days	1.0
2,4,5-TP-Silvex	8151A	7 days	5.0
Glyphosate	547	7 days	5.0

Table 4.2. Analytical Methods, Holding Times, and Reporting Limits. (continued)

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)			
Acenaphthene	625	7 days	1.0
Acenaphthylene	625	7 days	2.0
Anthracene	625	7 days	2.0
Benzidine	625	7 days	5.0
Benzo(a)anthracene	625	7 days	5.0
Benzo(b)fluoranthene	625	7 days	10
Benzo(k)fluoranthene	625	7 days	2.0
Benzo(g,h,i)perylene	625	7 days	5.0
Benzo(a)pyrene	625	7 days	2.0
Benzyl butyl phthalate	625	7 days	10
Bis(2-chloroethyl)ether	625	7 days	1.0
Bis(2-chloroethoxy)methane	625	7 days	5.0
Bis(2-ethylhexyl)phthalate	625	7 days	5.0
Bis(2-chlorisopropyl)ether	625	7 days	2.0
4-Bromophenyl phenyl ether	625	7 days	5.0
2-Chloroethyl vinyl ether	625	7 days	1.0
2-Chloronaphthalene	625	7 days	5.0
4-Chlorophenyl phenyl ether	625	7 days	5.0
Chrysene	625	7 days	5.0
Dibenz(a,h)anthracene	625	7 days	0.1
1,3-Dichlorobenzene	625	7 days	1.0
1,2-Dichlorobenzene	625	7 days	1.0
1,4-Dichlorobenzene	625	7 days	1.0
3,3-Dichlorobenzidine	625	7 days	5.0
Diethylphthalate	625	7 days	2.0
Dimethylphthalate	625	7 days	2.0
Di-n-Butyl phthalate	625	7 days	10
2,4-Dinitrotoluene	625	7 days	5.0
2,6-Dinitrotoluene	625	7 days	5.0
4,6 Dinitro-2-methylphenol	625	7 days	5.0
1,2-Diphenylhydrazine	625	7 days	1.0
Di-n-Octyl phthalate	625	7 days	10
Fluoranthene	625	7 days	0.05
Fluorene	625	7 days	0.1
Hexachlorobenzene	625	7 days	1.0
Hexachlorobutadiene	625	7 days	1.0
Hexachloro-cyclopentadiene	625	7 days	5.0
Hexachloroethane	625	7 days	1.0
Indeno[1,2,3-cd]pyrene	625	7 days	0.05
Isophorone	625	7 days	1.0
Naphthalene	625	7 days	0.2
Nitrobenzene	625	7 days	1.0
N-Nitroso-dimethyl amine	625	7 days	5.0
N-Nitroso-diphenyl amine	625	7 days	1.0
N-Nitroso-di-n-propyl amine	625	7 days	5.0

Table 4.2. Analytical Methods, Holding Times, and Reporting Limits. (continued)

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L) (continued)			
Phenanthrene	625	7 days	0.05
Pyrene	625	7 days	0.05
1,2,4-Trichlorobenzene	625	7 days	1.0
4-Chloro-3-methylphenol	625	7 days	1.0
2-Chlorophenol	625	7 days	2.0
2,4-Dichlorophenol	625	7 days	1.0
2,4-Dimethylphenol	625	7 days	2.0
2,4-Dinitrophenol	625	7 days	5.0
2-Nitrophenol	625	7 days	10
4-Nitrophenol	625	7 days	5.0
Pentachlorophenol	625	7 days	2.0
Phenol	625	7 days	1.0
2,4,6-Trichlorophenol	625	7 days	10

SM = Method number from *Standard Methods for the Examination of Water and Wastewater* (APHA 1995).
1. Samples must be filtered within 48 hours.

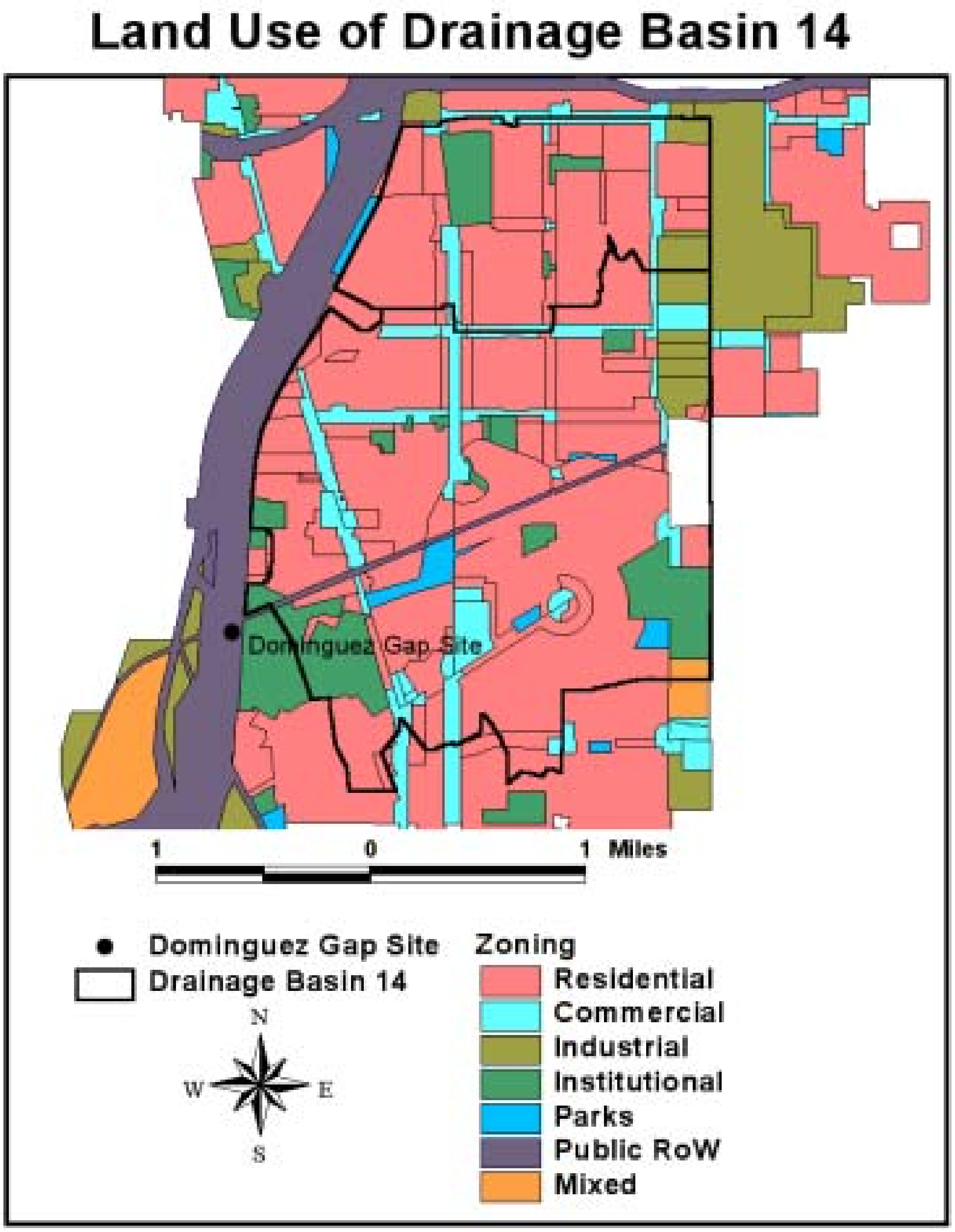


Figure 4.1. Land Use of Drainage Basin #14, which Drains to the Dominguez Gap Mass Emissions Site (Source: City of Long Beach Department of Technology Services, last update 12/20/00).

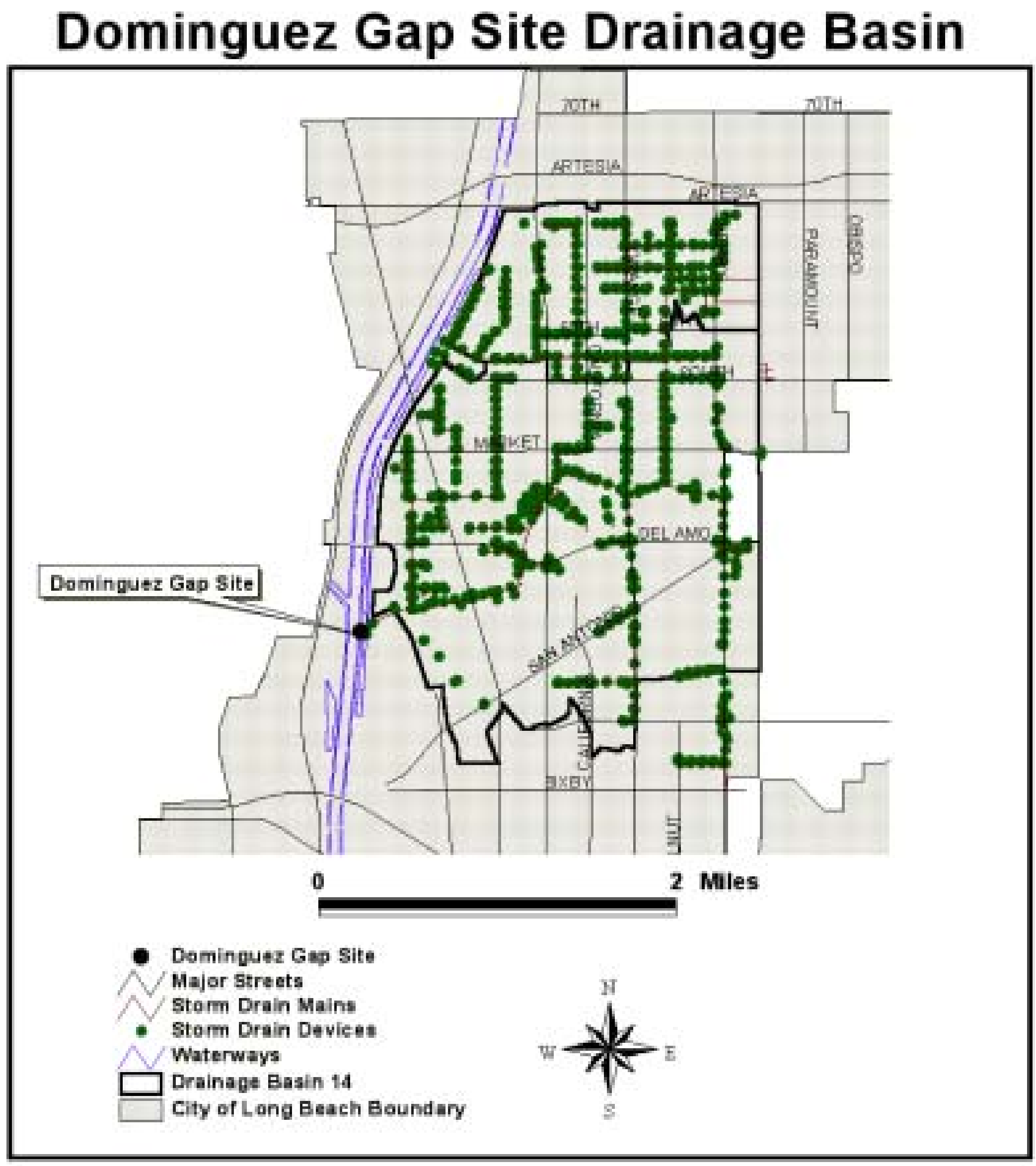


Figure 4.2. Dominguez Gap Mass Emissions Site and the City of Long Beach Drainage Basin #14 (Source: City of Long Beach, Department of Technology Services, last updated 1/9/00).

Figure 4.3 Dominguez Gap Pump Station Monitoring Site – Forebay and Monitoring Equipment

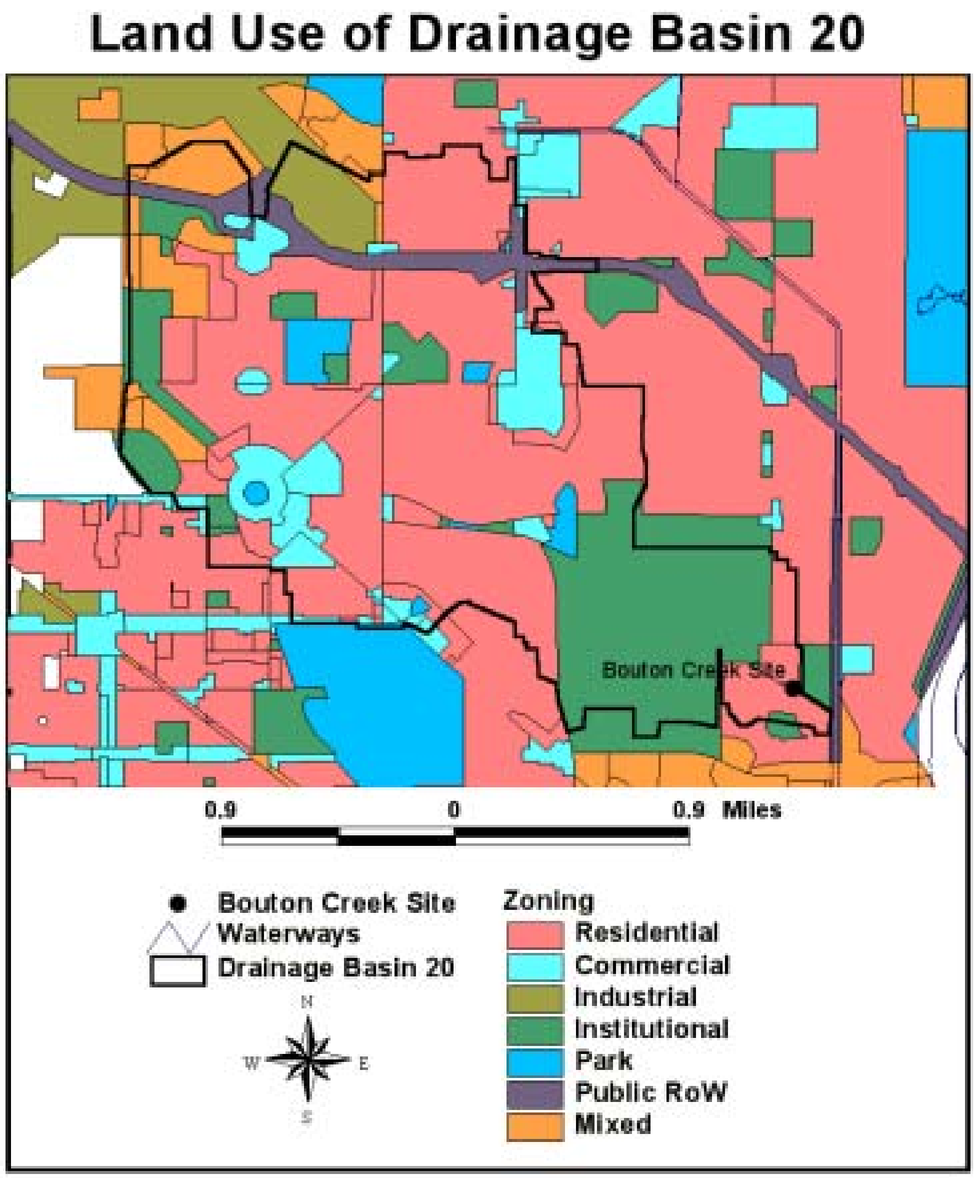


Figure 4.4. Land Use of Drainage Basin #20, which drains to the Bouton Creek Mass Emissions Site (Source: City of Long Beach, Department of Technology Services, last updated 12/20/00).

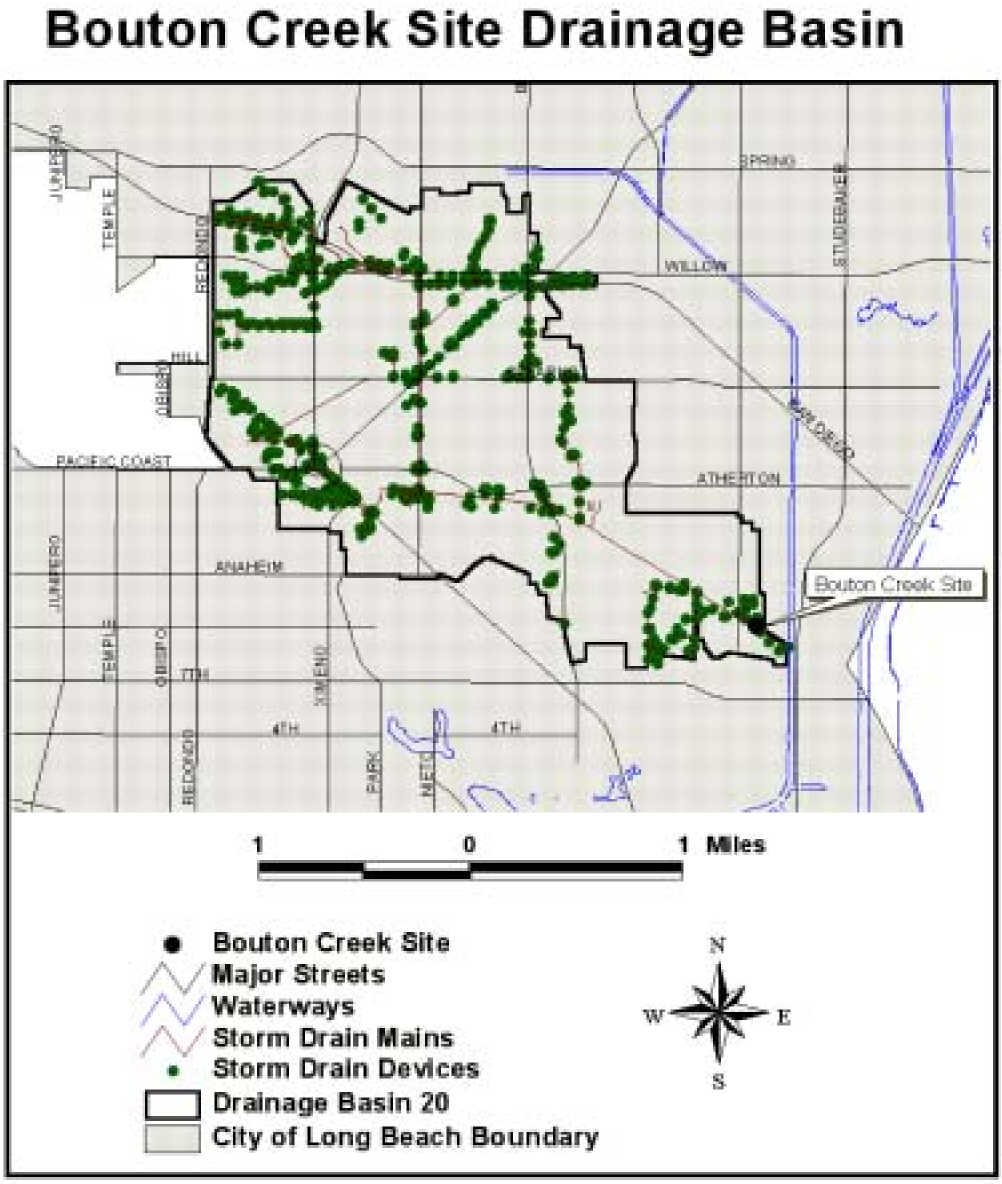


Figure 4.5. Bouton Creek Mass Emissions Site and City of Long Beach Drainage Basin #20. (Source: City of Long Beach, Department of Technology Services, last updated 1/9/00).

Figure 4.6 Bouton Creek Monitoring Site – Channel and Monitoring Equipment

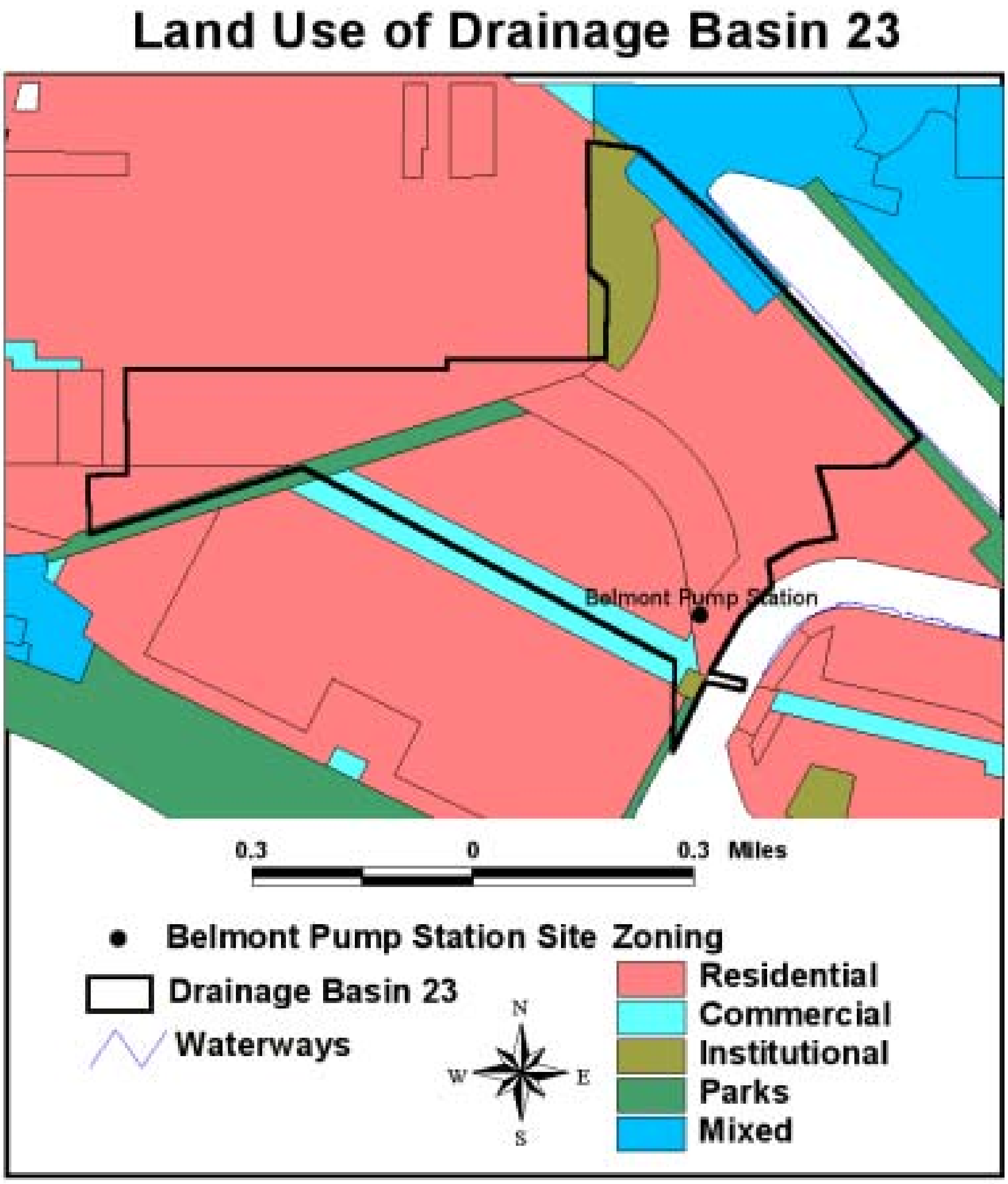


Figure 4.7. **Land Use of Drainage Basin #23, which Drains to the Belmont Pump Station Mass Emissions Site (Source: City of Long Beach, Department of Technology Services, last updated 12/20/00)**

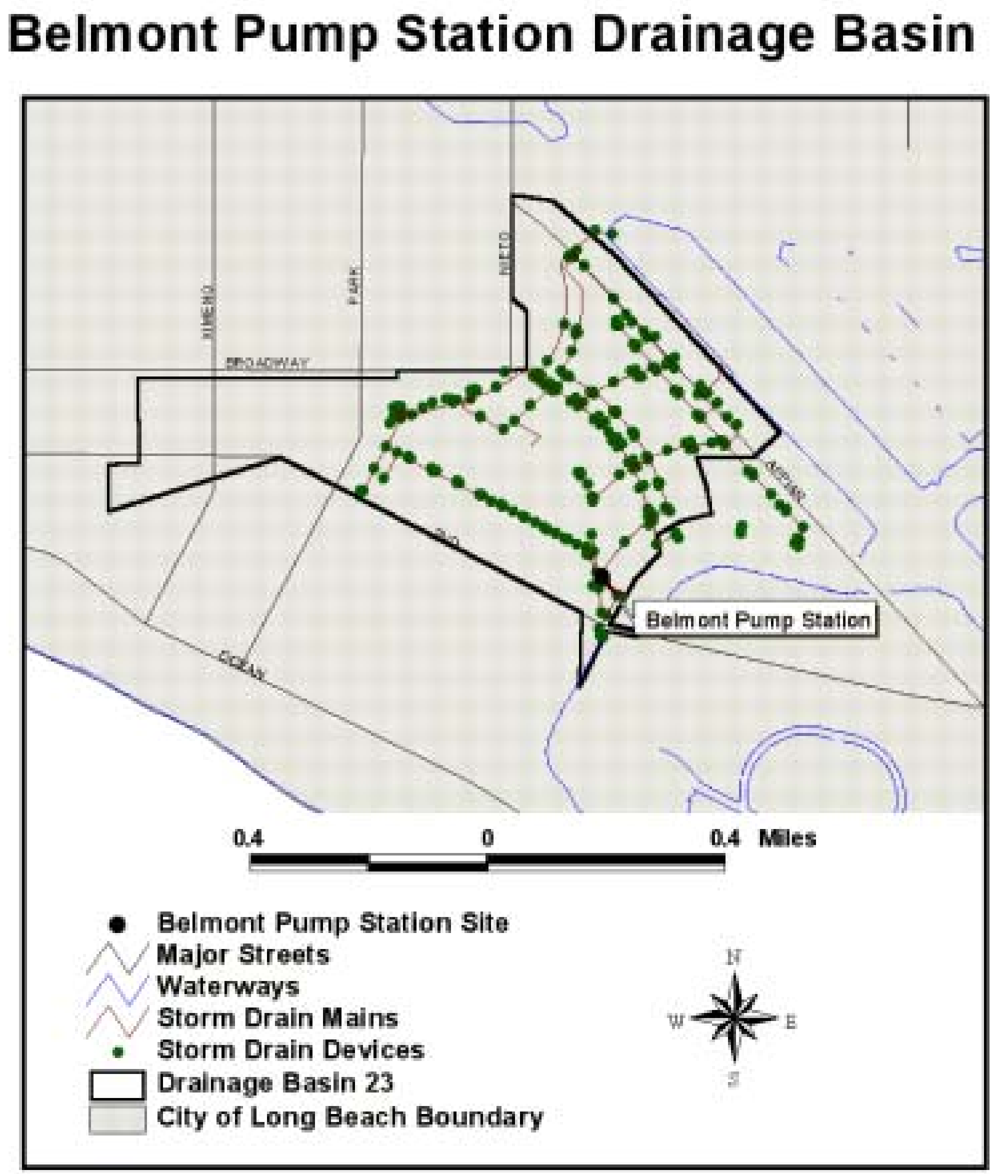


Figure 4.8. **Belmont Pump Station Mass Emissions Site and City of Long Beach Drainage Basin #23 (Source: City of Long Beach, Department of Technology Services, last updated 1/9/00).**

Figure 4.9 Belmont Pump Station Monitoring Site – Pump Station Outfall and Monitoring Equipment

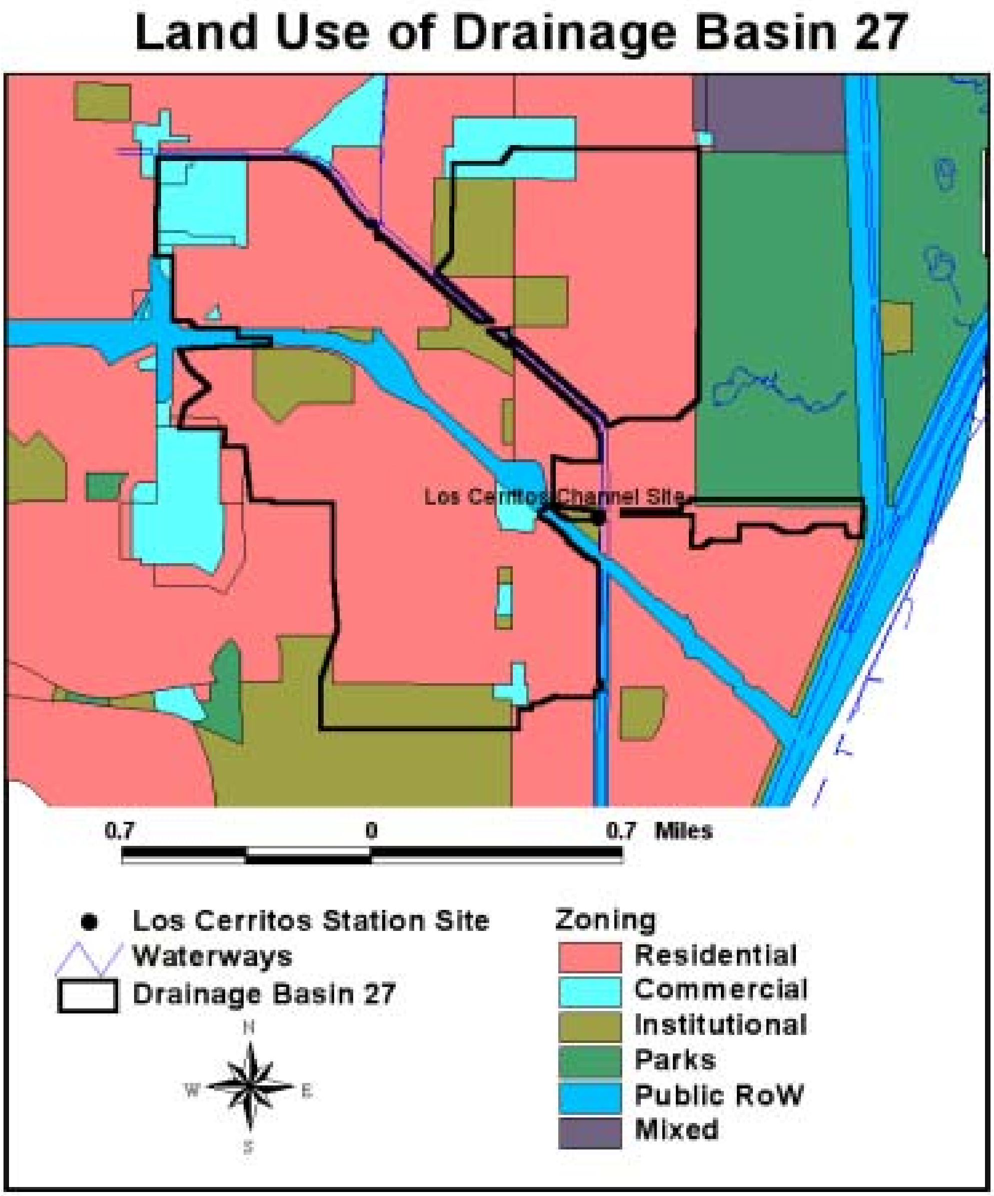


Figure 4.10. Land Use of Drainage Basin #27, which Drains to the Los Cerritos Channel Monitoring Site (Source: City of Long Beach, Department of Technology Services, last update 12/20/00).

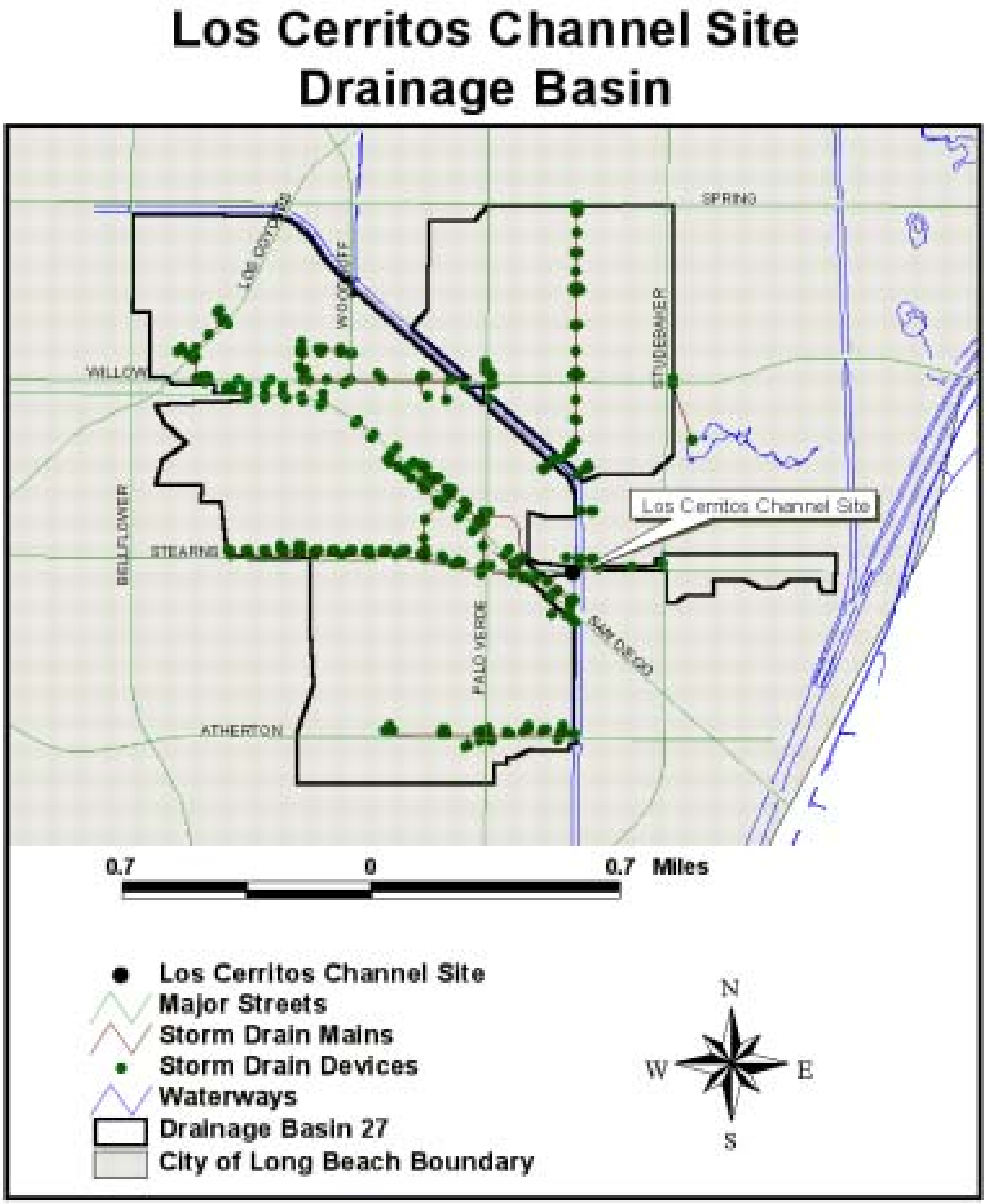


Figure 4.11. Los Cerritos Channel Mass Emissions Site and City of Long Beach Drainage Basin #27 (Source: City of Long Beach, Department of Technology Services, last updated 1/9/00).

Figure 4.12 Los Cerritos Channel Monitoring Site – Channel and Monitoring Equipment

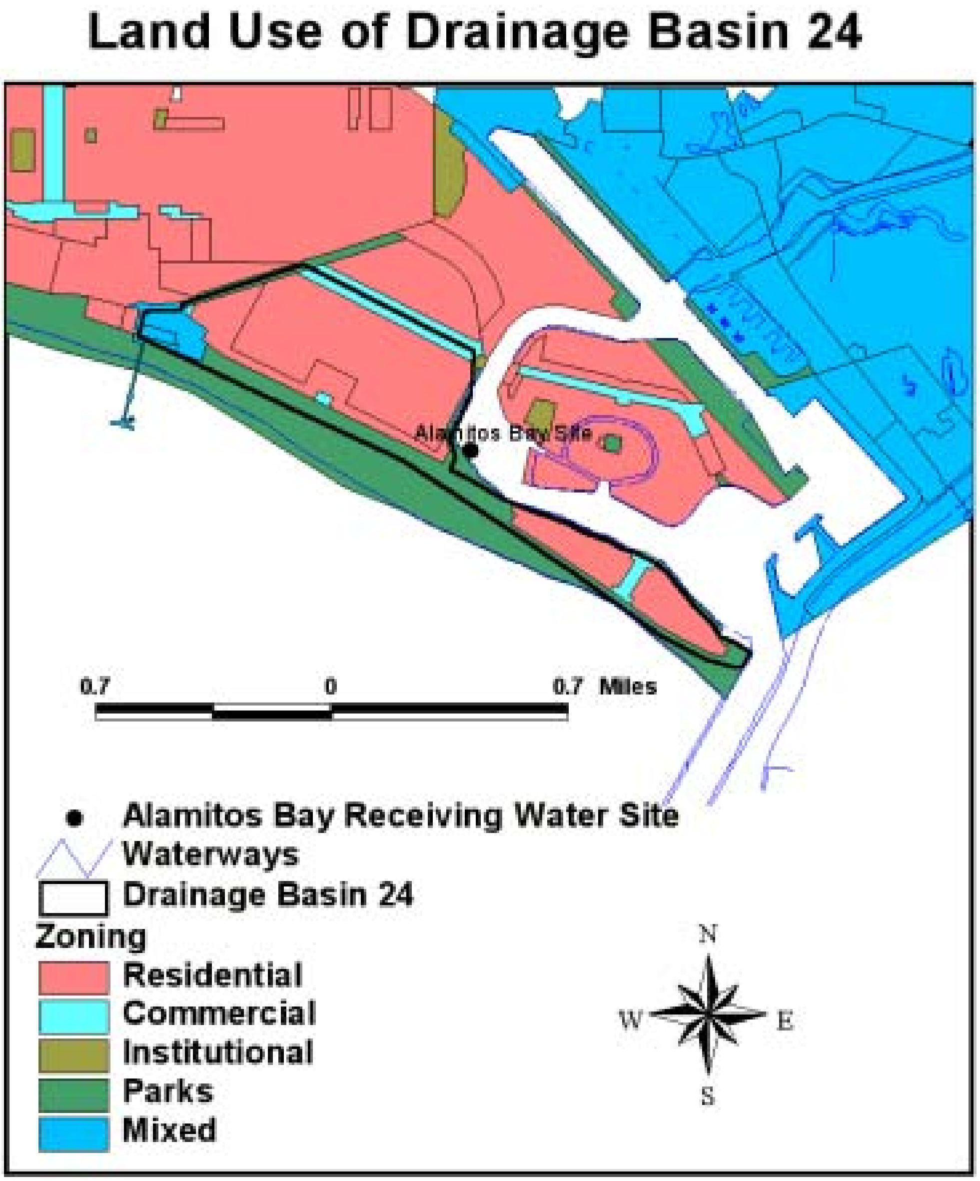


Figure 4.13. Land Use of Drainage Basin #24 which Drains to Alamitos Bay (Source: City of Long Beach, Department of Technology Services, last updated 12/20/00).

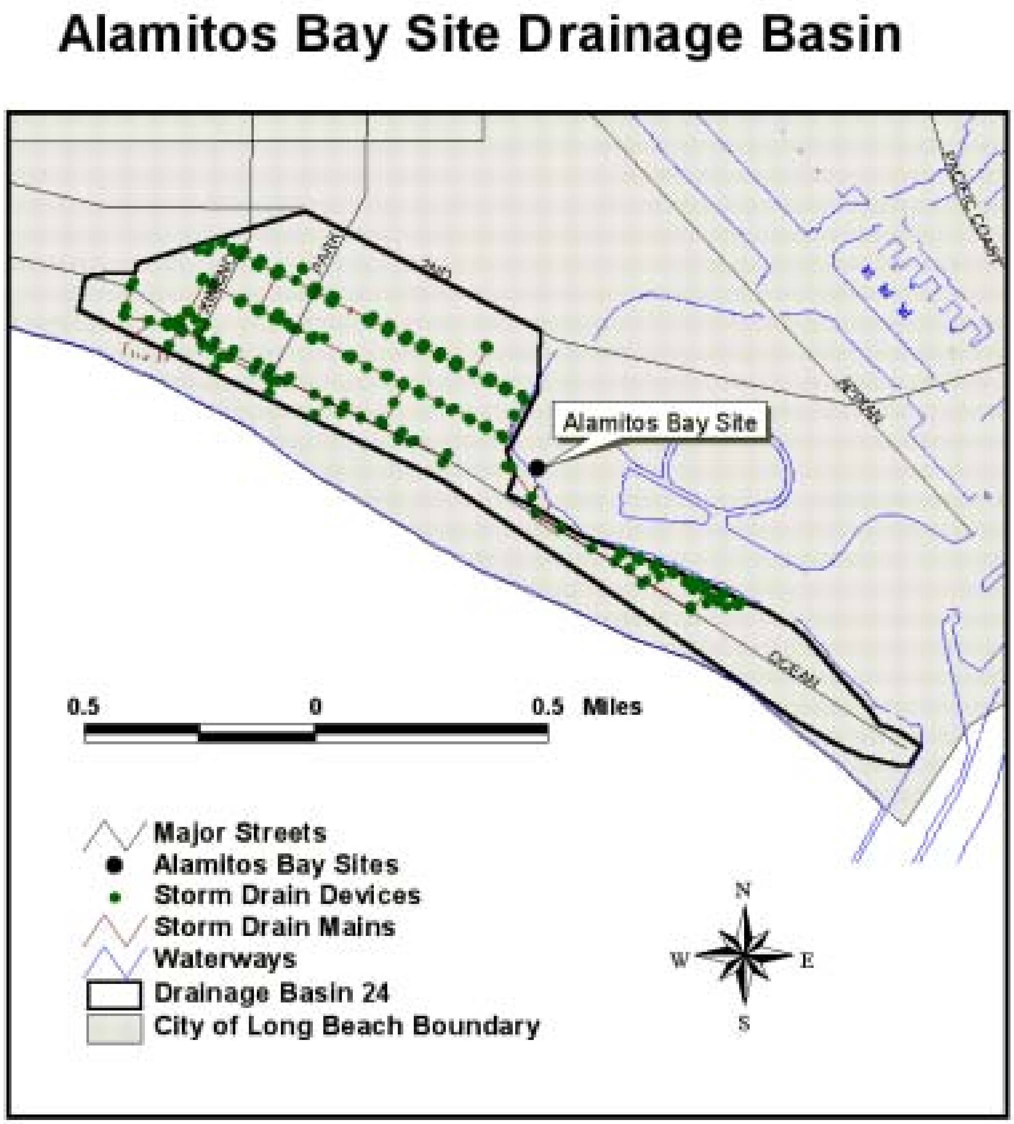


Figure 4.14. Alamitos Bay Receiving Water Site and City of Long Beach Drainage Basin #24 (Source: City of Long Beach, Department of Technology Services, last updated 1/9/00).

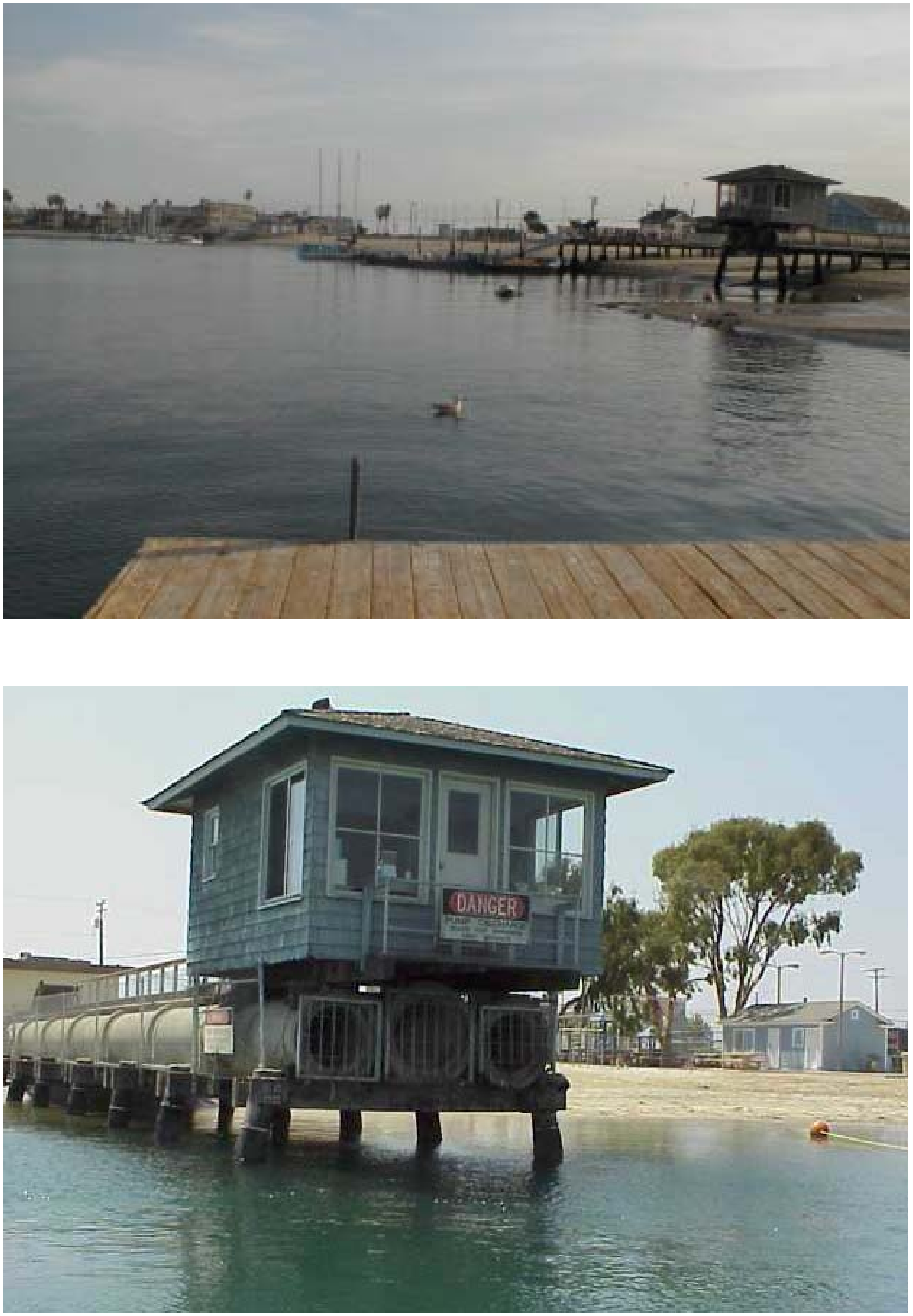
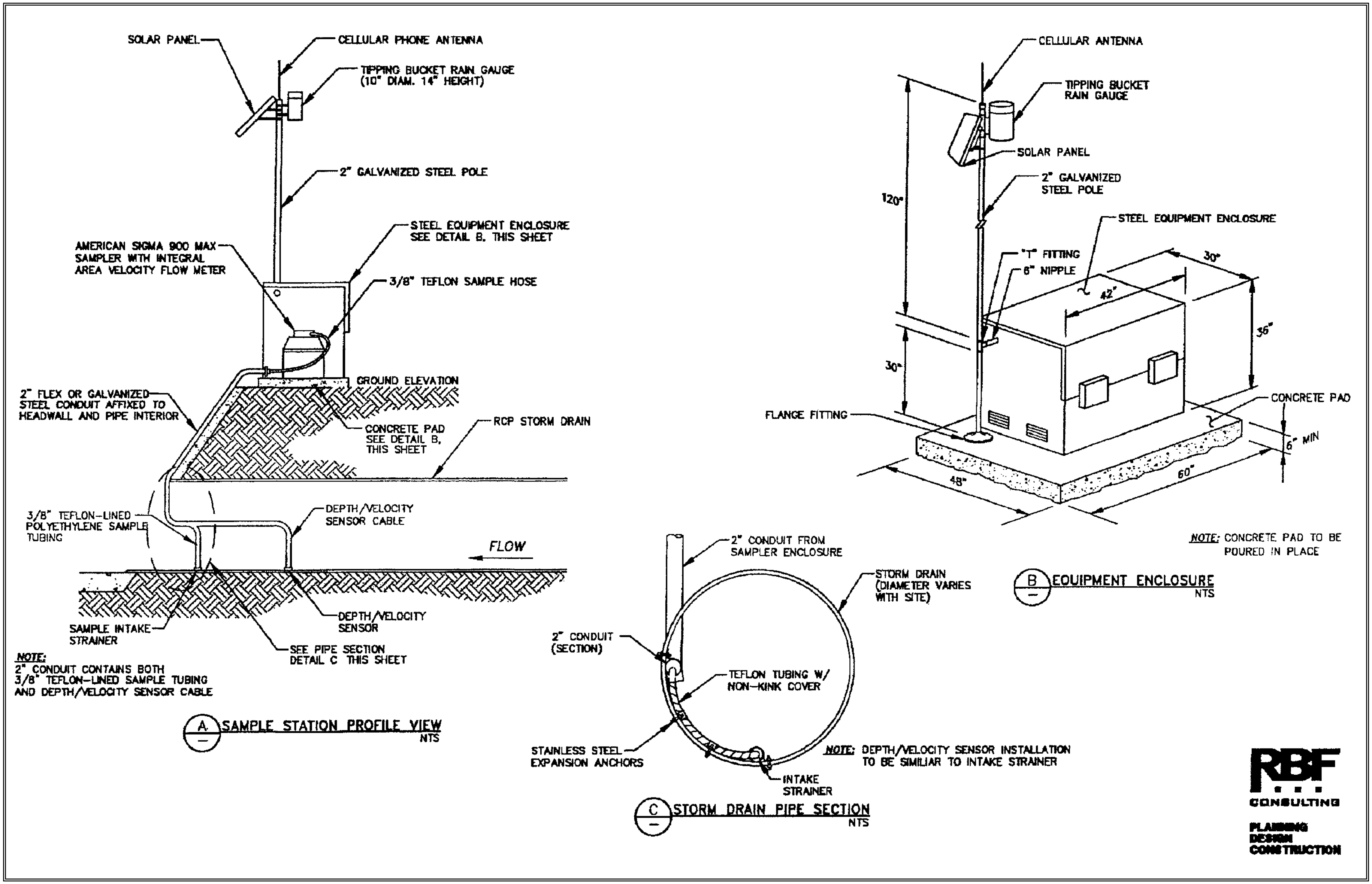


Figure 4.15 Alamitos Bay Receiving Water Monitoring Site – Sampling Site and Closeup of Outfall

Figure 4.16. Typical KLASS Stormwater Monitoring Station.



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5.0 HYDROLOGY

All Long Beach monitoring stations were fully operational at the start of the 2001/2002 wet weather season. Precipitation and discharge were continuously monitored throughout the season. The first two major storm events of the season were captured at three of the stations including the Belmont Pump Station, Los Cerritos Creek and Bouton Creek. Neither event was sufficient to produce a discharge at the Dominguez Gap Pump Station. Due to the rapid capture of these two events, a decision was made to delay further sampling until later in the season to assure adequate temporal coverage. This decision was also intended to allow for a greater probability of getting conditions that would produce runoff at the Dominguez Gap Pump Station. Unexpected drought conditions throughout the early months of 2002 prevented collection of further stormwater runoff inspite of numerous false-event attempts.

5.1 Precipitation during the 2001/2002 Storm Season

Precipitation during the 2001/2002 water year was far below normal in Long Beach according to the National Weather Service climate station at Long Beach Airport (Figure 5.1). During the prior season, a total of 13.32 inches of rain was recorded at the Long Beach Airport from October, 2000 and April, 2001. This season, only 1.99 inches of rainfall was recorded at the airport during this time period. This level of rainfall was only 16 percent of historical average seasonal rainfall. Normal precipitation for October through April at the Long Beach Airport is 12.27 inches.

Rainfall was relatively uniform at each of the monitoring stations with seasonal totals ranging from 2.99 inches at the Dominguez Pump Station to 3.86 inches at the Los Cerritos stormwater monitoring site.

5.1.1 Monthly Precipitation

January and February are characteristically the wettest months of the storm season (Figure 5.1) in Long Beach. Normal rainfall during these two months averages nearly six inches and typically represents half of the season's total precipitation. During January and February 2002, total rainfall was only 0.32 inches, accounting for only 16 percent of total rainfall for the season. Between 70 and 80 percent of the wet season rainfall occurred in November and December of 2001.

5.1.2 Precipitation during Monitored Events

Precipitation during each storm event was characterized by total rainfall, duration of rainfall, maximum intensity, days since last rainfall, and the magnitude of the event immediately preceding the monitored storm event (antecedent rainfall). Precipitation characteristics for each event are summarized in Table 5.1. Cumulative descriptive statistics for each monitoring station are presented in Table 5.3. Cumulative rainfall and intensity are summarized graphically for each monitored event at each station in Figures 5.2 through 5.7.

The two events monitored during the 2001/2002 wet weather season were the first and second events of the year. Both were relatively small events characterized by brief, intense periods of scattered shower activity. Total rainfall for the first event ranged from 0.23 to 0.39 inches. The second event yielded 0.33 to 0.39 inches of rain. The majority of rain fell during very short time periods as indicated by intensities of approximately one inch per hour occurring during each storm. Rainfall characteristics were, however, quite variable among sites. Rainfall at the Bouton Creek site was characterized by light rainfall during extended time periods during both events.

5.2 Stormwater Runoff during Monitored Events

Monitoring was designed to isolate rainfall events and the runoff created by those events. Table 5.2 summarizes flow characteristics among monitored events at each station. Table 5.3 provides descriptive statistics for all monitored events since initiation of the monitoring program. This information complements Event Mean Concentration (EMC) statistics for each monitored analyte at these sites. Figures 5.2 through 5.7 graphically depict flow during each monitored event at each station in response to rainfall. These figures also show how the aliquoting of each composite sample was conducted.

Runoff duration at the Belmont Pump Station was very brief during both events. Discharges from the pump station lasted between 15 and 45 minutes. Runoff duration at the two other sites with larger drainages occurred over extended time periods ranging from roughly 10 to 17 hours. Flow duration was typically greatest at Bouton Creek due to tidal effects. During incoming tides, low flows are backed up and held back by the tide. As the tide recedes, stormwater is detected at the station and sampling continues. This effect was most notable during the first event (Figure 5.3).

The percent storm captures (percentage of the total storm event volume effectively represented by the flow-weighted composite sample) were less than optimal in several cases. The intensity of rainfall combined with conservative sampling rates caused bottles to fill rapidly before crews could get to the sites to change bottles and settings. In all cases the rising limb of the hydrograph and periods of high flow were well represented by the samples.

Table 5.1. Rainfall for Monitored Events during the 2001/2002 Wet-Weather Season

Site/Event	Start Rain		End Rain		Duration Rain (hrs:mins)	Total Rain (inches)	Max Intensity (Inches/hr)	Antecedent Rain (days)	Antecedent Rain (inches)
	Date	Time	Date	Time					
EVENT 1									
Belmont Pump Station	11/12/01	17:50	11/12/01	19:00	1:10:00	0.23	0.6	1.24	0.03
Bouton Creek	11/12/01	18:00	11/13/01	9:40	15:40:00	0.28	0.12	1.17	0.02
Los Cerritos Creek	11/12/01	17:55	11/13/01	0:00	6:05:00	0.39	1.2	8.2	0.03
Dominguez Gap Pump Station	NA								
EVENT 2									
Belmont Pump Station	11/24/01	13:45	11/24/01	16:35	2:50:00	0.33	0.96	11.8	0.23
Bouton Creek	11/24/01	13:15	11/25/01	5:40	16:25:00	0.36	0.12	10.7	0.28
Los Cerritos Creek	11/24/01	13:25	11/24/01	16:40	3:15:00	0.39	0.96	11.6	0.39
Dominguez Gap Pump Station	NA								

NA = Not Available, no events occurred at the Dominguez Gap Pump Station

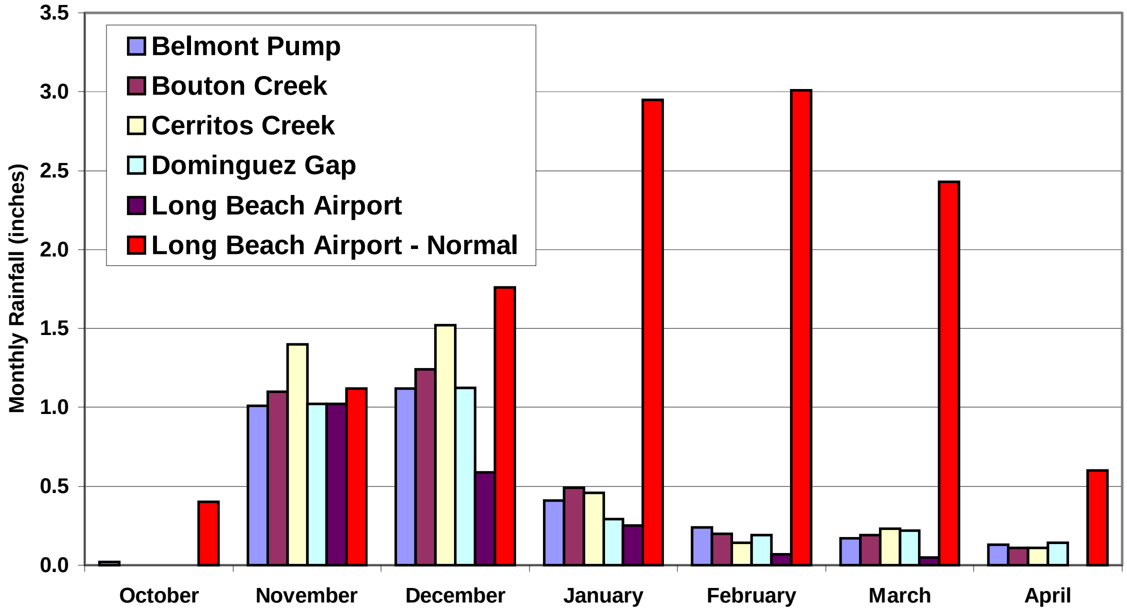
Table 5.2. Flow for Monitored Events during the 2001/2002 Wet-Weather Season

Site/Event	Start Flow		End Flow		Duration Flow (hrs:mins)	Total Flow (kilo-cubic feet)	No. of Sample Aliquots Collected	Peak Flow (cfs)	% Capture	Peak Capture
	Date	Time	Date	Time						
EVENT 1										
Belmont Pump Station	11/12/01	18:35	11/12/01	18:50	0:15	42.6	3	66	100	Y
Bouton Creek	11/12/01	18:35	11/13/01	11:40	17:05	608	28	162.5	60.2	Y
Los Cerritos Creek	11/12/01	17:55	11/13/01	3:35	9:40	2857	46	487.6	51.7	N
Dominguez Gap Pump Station										
EVENT 2										
Belmont Pump Station	11/24/01	14:50	11/24/01	15:35	0:45	90.1	6	66	93.4	Y
Bouton Creek	11/24/01	13:25	11/25/01	3:30	14:05	1066	51	161.2	79.5	Y
Los Cerritos Creek	11/24/01	14:05	11/25/01	1:00	10:55	7072	95	1378	90.3	Y
Dominguez Gap Pump Station										

Table 5.3. Cumulative Descriptive Statistics for Rainfall and Flow Data for All Monitored Events (2000-2002)

Site / Parameter	n	Min	Max	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile
BELMONT PUMP ST.								
Duration Flow (days)	6	0.01	1.8	0.5	0.7	0.0	0.1	0.6
Total Storm Vol. (kcf)	6	43	331	112	109	55	79	90
Duration Rain (days)	7	0.05	1.17	0.41	0.43	0.11	0.15	0.64
Total Rain (in)	7	0.23	0.93	0.46	0.27	0.26	0.33	0.60
Max Intensity (in/hr)	7	0.24	1.20	0.65	0.37	0.36	0.60	0.90
Antecedent Dry (days)	7	1.1	28.0	9.6	9.7	1.5	9.4	12.8
Antecedent Rain (in)	7	0.03	2.39	0.56	0.84	0.14	0.23	0.49
BOUTON CREEK								
Duration Flow (days)	6	0.6	2.7	1.4	0.8	0.8	1.3	1.8
Total Storm Vol. (kcf)	6	608	2755	1252	818	695	962	1453
Duration Rain (days)	6	0.6	2.5	1.2	0.8	0.6	0.7	1.7
Total Rain (in)	6	0.28	0.89	0.50	0.25	0.35	0.37	0.65
Max Intensity (in/hr)	6	0.12	1.20	0.46	0.40	0.18	0.42	0.48
Antecedent Dry (days)	5	1.2	28.0	12.6	9.9	8.7	10.7	14.3
Antecedent Rain (in)	5	0.02	3.05	0.86	1.25	0.22	0.28	0.74
LOS CERRITOS CHANNEL								
Duration Flow (days)	6	0.4	0.7	0.5	0.1	0.4	0.5	0.6
Total Storm Vol. (kcf)	7	1582	7072	3557	1884	2303	2857	4391
Duration Rain (days)	6	0.1	0.5	0.3	0.2	0.2	0.3	0.5
Total Rain (in)	7	0.19	0.60	0.35	0.13	0.27	0.33	0.39
Max Intensity (in/hr)	7	0.36	1.20	0.70	0.31	0.48	0.60	0.90
Antecedent Dry (days)	7	1.8	28.0	11.6	8.7	5.9	11.6	13.9
Antecedent Rain (in)	7	0.03	0.60	0.24	0.21	0.11	0.13	0.36
DOMINGUEZ GAP PUMP ST.								
Duration Flow (days)	3	0.1	1.7	0.7	0.9	0.2	0.3	1.0
Total Storm Vol. (kcf)	3	812	7528	3903	3390	2091	3370	5449
Duration Rain (days)	4	0.7	2.9	1.6	1.1	0.8	1.4	2.2
Total Rain (in)	4	0.39	2.68	1.43	1.14	0.51	1.33	2.25
Max Intensity (in/hr)	4	0.24	0.84	0.45	0.27	0.33	0.36	0.48
Antecedent Dry (days)	4	1.8	13.9	7.5	5.2	4.4	7.1	10.2
Antecedent Rain (in)	4	0.27	3.50	1.66	1.59	0.36	1.44	2.74

Figure 5.1 Monthly Rainfall Totals for the 2001/2002 Wet Weather Season and Normal Rainfall at Long Beach Daugherty Air Field.



	Belmont Pump	Bouton Creek	Los Cerritos Creek	Dominguez Gap	Long Beach Airport	Long Beach Airport-Normal
October	0.02	0.00	0.00	0.00	0.00	0.40
November	1.01	1.10	1.40	1.02	1.02	1.12
December	1.12	1.24	1.52	1.13	0.59	1.76
January	0.41	0.49	0.46	0.29	0.25	2.95
February	0.24	0.20	0.14	0.19	0.07	3.01
March	0.17	0.19	0.23	0.22	0.05	2.43
April	0.13	0.11	0.11	0.14	0.00	0.60
Season Totals	**3.10**	**3.33**	**3.86**	**2.99**	**1.98**	**12.27**

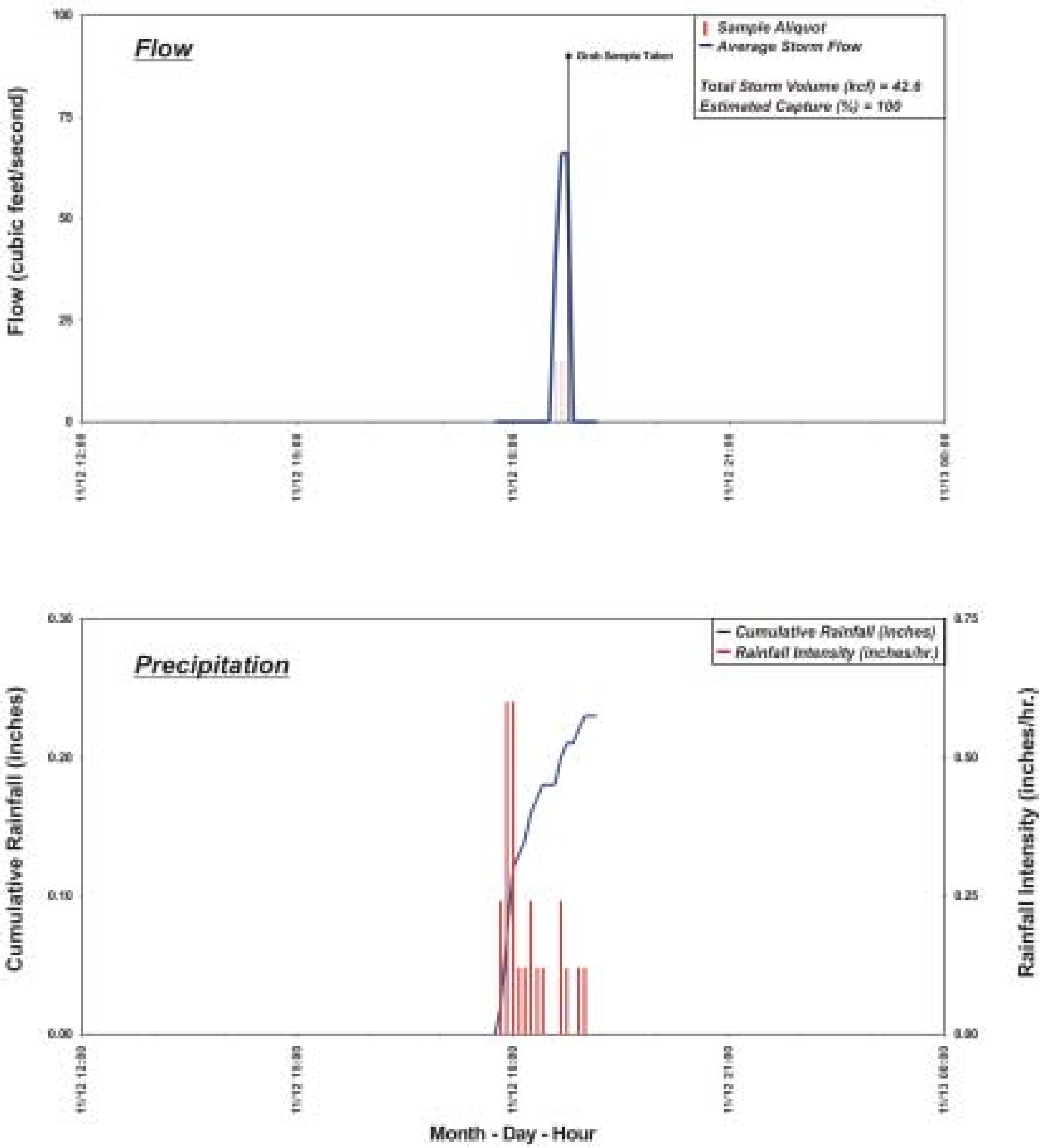


Figure 5.2. Belmont Pump Station – Event 1 (12 November, 2001)

Figure 5.3. Bouton Creek – Event 1 (12-13 November, 2001)

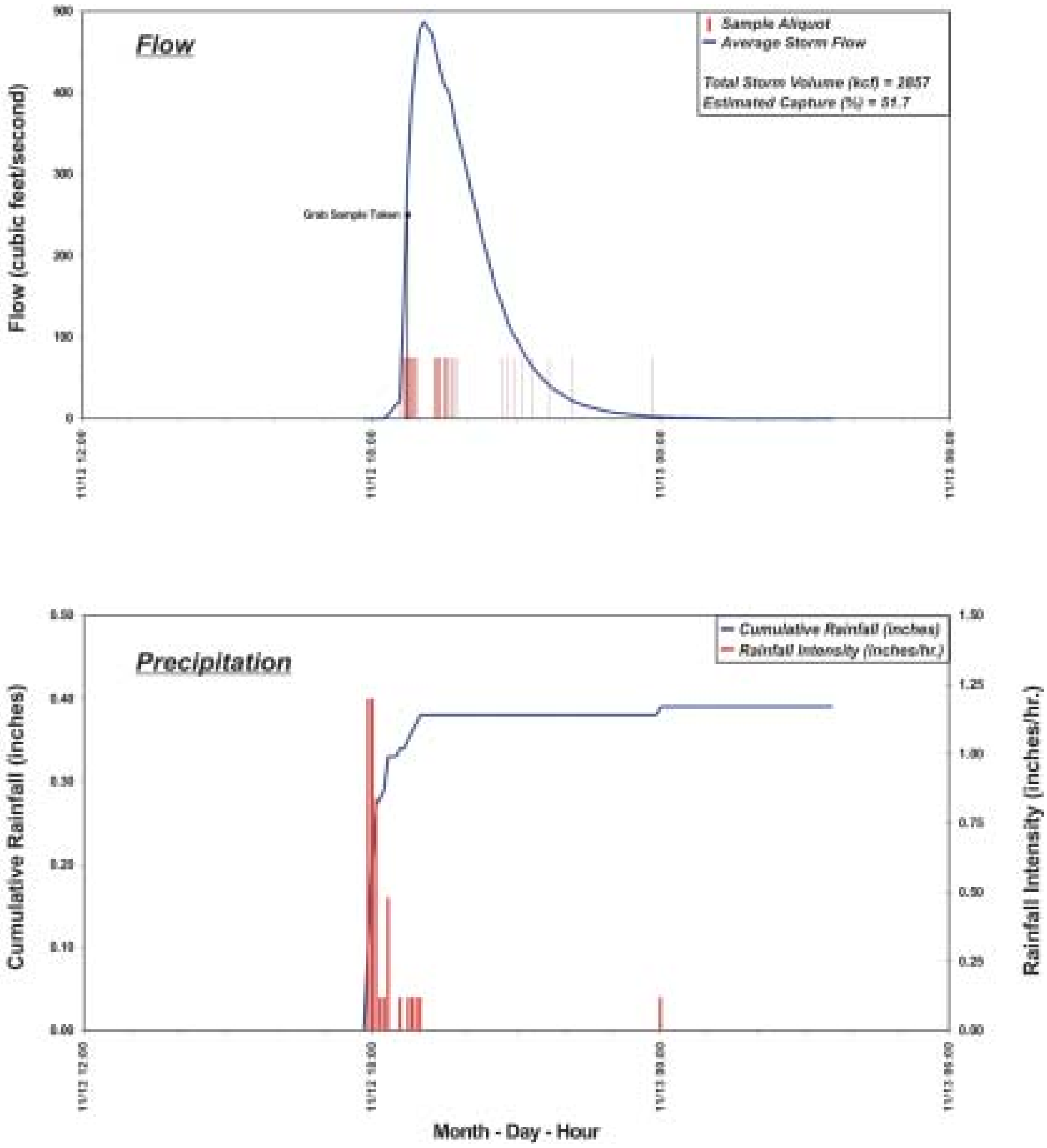


Figure 5.4. **Los Cerritos Channel –Event 1 (12 November, 2001)**

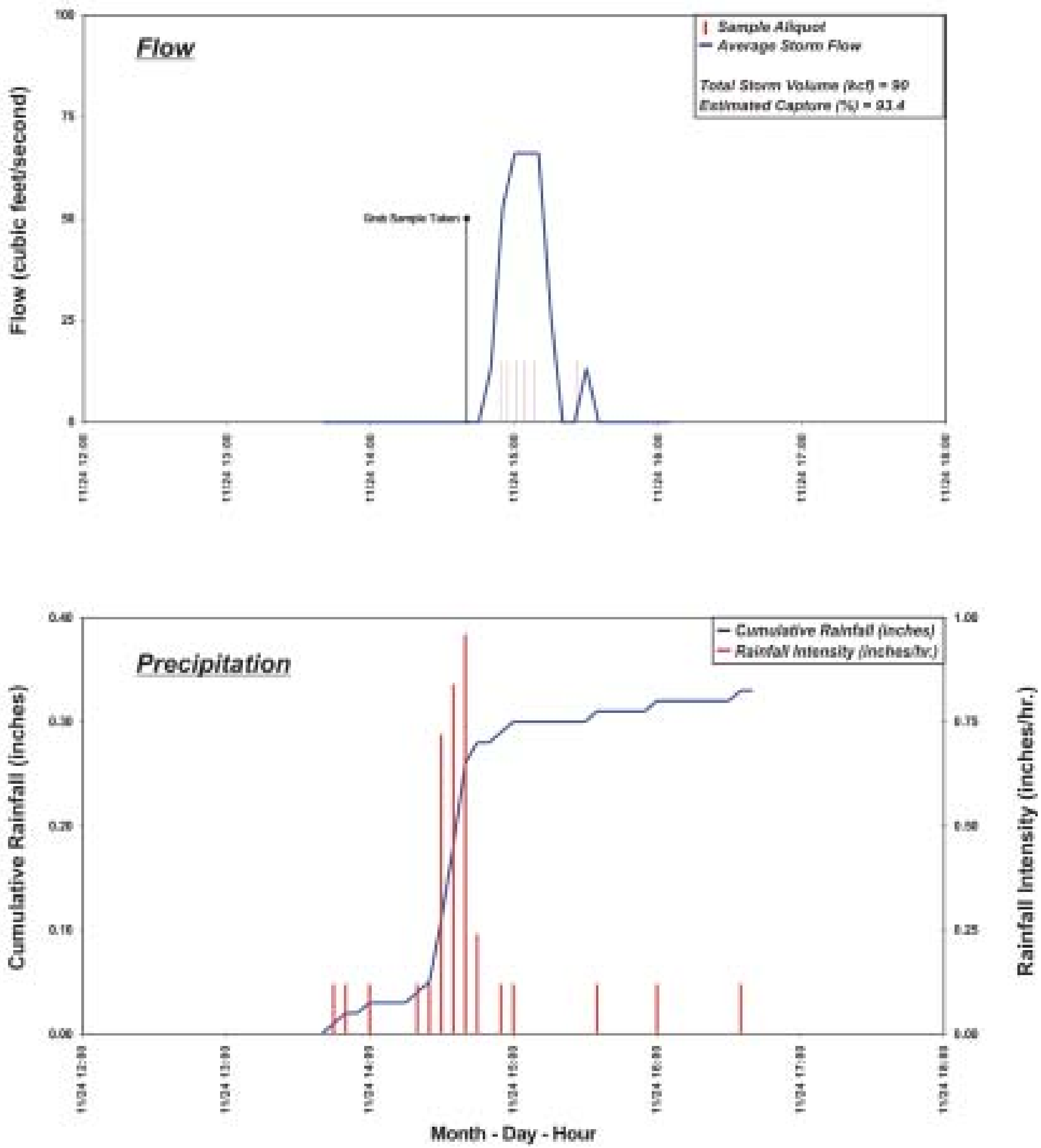


Figure 5.5. Belmont Pump Station – Event 2 (24 November, 2001)

Figure 5.6. Bouton Creek – Event 2 (24-25 November, 2001)

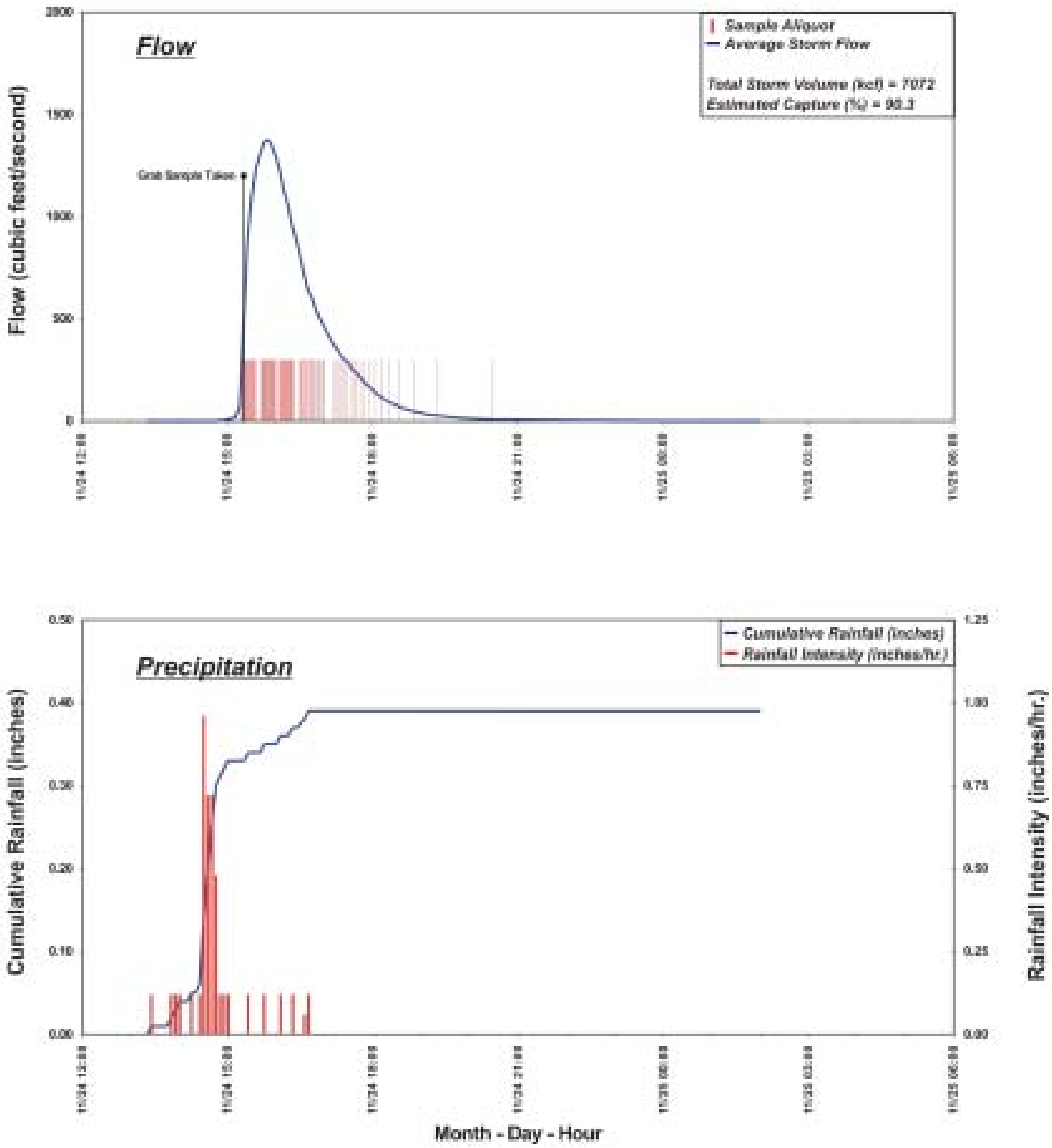


Figure 5.7. Los Cerritos Channel – Event 2 (24 November, 2001)

6.0 CHEMISTRY RESULTS

6.1 Wet Weather Chemistry Results

Due to drought conditions in the study area, only two events were successfully sampled at each of three sites. However, these events represented seasonal first flush at the monitoring sites. These seasonal first flush events were not captured during the previous year as the instrumentation was not in place until January of that year. No discharges occurred from the Dominguez Gap pump station during this entire year. The events that were monitored at each site, successfully sampled, and sent to the laboratories for analysis are summarized in Table 6.1.

For each of these monitored events, all chemical constituents summarized in Table 4.2 above were analyzed in the resulting samples for all stations. Receiving waters were also sampled during these two wet weather events. Samples were analyzed for toxicity and bacteria.

Composite samples collected during these storm events were also tested for toxicity with three species, the water flea (freshwater crustacean), mysid (marine crustacean), and sea urchin (marine).

The results of the chemical analysis of these composite and grab stormwater samples are summarized in Table 6.2. Bacterial results for the Alamitos Bay receiving water site are summarized in Table 6.4. Toxicity results for the composite samples and the receiving water samples from these monitored events are given in Section 7 below.

6.2 Dry Weather Sampling Results

The City's NPDES Permit calls for two dry weather inspections and sampling events to be carried out during the summer dry weather period at each of the four mass emission stations as well as samples to be taken at the Alamitos Bay receiving water site. During the 1999/2000 year, the two dry weather inspections/sampling events were done in late June so that the results could be reported in the annual report due 15 July 2000. For the second year, the first of these dry weather inspections/samplings was done at all sites in June 2001 and the results are reported in this annual report. However, it was decided that it would be better to do the second sampling event later in the summer such that dry weather surveys bracketed the storm season. This event was conducted on 16 August 2001 and the results are reported as an addendum that is included as Appendix F of this annual report. Data from the August 2001 (Dry Weather Event 5) survey are included in the data tables for comparison purposes. The dry weather events monitored during the 1999/2000, 2000/2001 and 2001/2002 seasons are summarized in Table 6.3. Events 5 and 6 conducted during the past monitoring season are shaded. Microbiological data from Alamitos Bay are summarized in Table 6.4. Field water quality measurements associated with the 2001/2002 dry weather surveys are summarized in Tables 6.5. The results of chemical analysis of the both the August 2001 and May 2002 dry weather surveys are presented in Table 6.6.

6.2.1 Basin 14: Dominguez Gap Monitoring Site

An inspection for dry weather flow was conducted at the Dominguez Gap Pump Station on 7 May 2002. No dry weather flow was observed. The basin in front of the pump house had standing water in it but field crews were unable to reach the water to measure the depth. The source of this ponded water was not determined due to the lack of current flow from any source. The concrete lined channel that extends east from, and discharges into, the basin had small, isolated pools of standing water, but there was no flow. The construction activity that took place on the railroad bridge just north of the pump house is completed. The earth dam that was placed across the basin just north of the pump house to provide convenient vehicle access to the eastside of the swale has been removed. There was no flow from the north part of the basin observed. It is apparent that water from the Los Angeles River was not being diverted into the swale for ground water recharge as was observed in 2001.

6.2.2 Basin 20: Bouton Creek Monitoring Site

Bouton Creek was sampled on 14 May 2002 from 6:00 a.m. to 8:00 a.m. This time corresponded to a period of low tide when the flow in the creek was not impeded by seawater backing into the creek. The tide levels at this time were between negative 0.21 and plus 1.0 feet in the Long Beach area. This assured that the flow was fresh water flowing downstream in the creek and that that saline tidal water did not commingle with the dry weather discharge of fresh water.

Every 20 minutes during the two-hour period, a 2.86-liter aliquot of water was pumped from the creek using the automatic sampler installed at the site. An aliquot was deposited into each of four 20-liter borosilicate glass bottles. At the conclusion of the sampling, grab samples for MTBE, TPH and bacteria were collected. All samples were chilled to 4° C, and transported to the appropriate laboratory for analysis. Conductivity and pH measurements were also taken at this time and these field measurements are summarized in Table 6.5.

6.2.3 Basin 23: Belmont Pump Station Monitoring Site

Time weighted composite sampling was conducted over a 24 hour period starting on 8 May 2002 and ending on 9 May 2002. Samples were collected from the sump using the automated sampler installed outside of the pump house. Samples were collected into three 20-liter bottles. Every half-hour for the 24 hours, an aliquot of approximately 1.25 liters of water was pumped from the sump into a 20-liter bottle. The bottles were changed every eight hours and chilled to 4°C with ice during sampling and transportation. Following completion of the sampling, the three bottles of water were combined into a composite. Upon completion of the 24-hour sampling, on 9 May 2002, at 7:15 a.m., grab samples for MTBE, TPH and bacteria were manually collected from the sump. All samples were chilled to 4° C and transported to the appropriate laboratory for analysis.

6.2.4 Basin 27: Los Cerritos Channel Monitoring Site

Time weighted sampling was conducted over a 24-hour period of the water flowing through the channel. Sampling was started on 8 May 2002 and completed on 9 May 2002. Samples were taken from the middle of the channel using the automated sampler installed on the bank of the channel. The dry weather flow is a narrow stream approximately 22 feet wide and 1.5 inches deep located in the middle of the channel. To reach the water, the sampling hose that is used for sampling stormwater was extended an additional 33 feet. Samples were collected into three 20-liter bottles. Every half-hour for 24 hours, an aliquot of approximately 1.25 liters of water was pumped into a 20-liter bottle. The bottles were changed every eight hours and chilled to 4°C with ice during sampling and transportation. Following completion of the sampling, the three bottles of water were combined into a composite sample. After completion of the 24-hour sampling, on May 9 at 4:55 a.m., grab samples were manually collected for MTBE, TPH and bacteria. All samples were chilled to 4° C and transported to the appropriate laboratory for analysis.

6.2.5 Basin 23: Alamitos Bay Receiving Water Monitoring Site

Samples of water were collected at the Alamitos Bay Receiving Water Site occupied during the wet season in the vicinity of the pump station outfall from Basin 24. The samples were collected from the end of the swimming dock just north of the outfall. Sampling was done on the morning of May 9, 2002 at 5:10 a.m. The outfall has a low-flow diverter that prevents dry weather flow from being discharged into the Bay. Samples for toxicity testing were collected in 1-gallon amber glass bottles by dipping them approximately one foot below the surface. In addition, grab-samples for bacteria were also collected from the same site. All samples were cooled to 4° C and transported to the appropriate laboratories for analysis. Results of the bacterial analyses for these dry weather samples are summarized in Table 6.4.

Table 6.1. Monitored Storm Events, 2001/2002

Station	Event 1 12 Nov '01	Event 2 24 Nov '01
Bouton Creek	**X**	**X**
Belmont Pump	**X**	**X**
Los Cerritos Channel	**X**	**X**
Dominguez Gap	**NF**	**NF**

NF = No Flow as the Pump Station did not discharge to the Los Angeles River.

Table 6.2. Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 1 of 5)

ANALYTE	Belmont Pump 1	Belmont Pump 1FD	Belmont Pump 2	Bouton Creek 1	Bouton Creek 2	Los Cerritos Channel 1	Los Cerritos Channel 1FD	Los Cerritos Channel 2	Los Cerritos Channel 2FD	Alamitos Bay 1	Alamitos Bay 2
	12 Nov '01	12 Nov '01	24 Nov '01	13 Nov '01	24 Nov '01	12 Nov '01	12 Nov '01	24 Nov '01	24 Nov '01	12 Nov '01	24 Nov '01
CONVENTIONALS											
BOD5 (mg/L)	**24**	**22**	**22J**	**31**	**19J**	**49**	-	**16J**	**23J**	-	-
COD (mg/L)	**94**	**110**	**68**	**120**	**68**	**95**	-	**48**	**46**	-	-
TOC (mg/L)	**49J**	**57**	**22**	**52J**	**32**	**58J**	-	**21**	**22**	-	-
EC (umhos/cm)	**460**	**470**	**150**	**710**	**180**	**180**	-	**96**	**95**	-	-
Hardness (mg/L)	**100**	**92**	**37**	**100**	**46**	**68**	-	**27**	**39**	-	-
Alkalinity (mg/L)	**71**	**78**	**21**	**33**	**22**	**120**	-	**17**	**17**	-	-
pH (units)	**7.8**	**7.4**	**7.2**	**7.3**	**7.3**	**7.4**	-	**7.4**	**7.4**	-	-
Cyanide (ug/L)	5U	5U	5U	5U	5U	5U	-	5U	5U	-	-
Chloride (mg/L)	**72J**	**63J**	**20J**	**170J**	**26J**	**52J**	-	**6.7J**	**6.2J**	-	-
Fluoride (mg/L)	**0.86J**	**0.90J**	**0.32J**	**1.3J**	**0.41J**	**0.66J**	-	**0.30J**	**0.28J**	-	-
TKN (mg/L)	**8.1**	**8.9**	**3.4**	**9.2**	**4.2**	**21**	-	**4.4**	**3.1**	-	-
Ammonia-N (mg/L)	**1.1**	**1.1**	**0.73**	**1.2**	**0.88**	**1.5**	-	**0.69**	**0.67**	-	-
Nitrite N (mg/L)	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	-	0.2U	0.2U	-	-
Nitrate N (mg/L)	**2.9**	**2.9**	**1.5**	**3.0**	**1.6**	**2.5**	-	**1.2**	**1.2**	-	-
Total Nitrogen	**11.1**	**11.9**	**5**	**12.3**	**5.9**	**23.6**	-	**5.7**	**4.4**	-	-
Total P (mg/L)	**2.10**	**2.20**	**0.990**	**1.70**	**0.800**	**6.20**	-	**1.40**	**0.710**	-	-
Diss. P (mg/L)	**0.510**	**0.490**	**0.590**	**0.380**	**0.380**	**0.470**	-	**0.320**	**0.310**	-	-
MBAS (mg/L)	**0.20**	**0.24**	**0.14**	**0.18**	**0.17**	**0.16**	-	**0.18**	**0.16**	-	-
MTBE (ug/L)	0.5U	0.5U	1.0U	0.5U	1.0U	0.5U	-	1.0U	1.0U	-	-
Tot. Phenols (mg/L)	0.1UJ	0.1UJ	0.1U	0.1UJ	0.1U	0.1UJ	-	0.1U	0.1U	-	-
Oil&Grease (mg/L)	**7.4**	-	5.0U	5.0U	5.0U	**7.4**	**29**	5.0U	5.0U	-	-
TRPH (mg/L)	5U	**10**	5U	5U	5U	5U	-	5U	5U	-	-
TSS (mg/L)	**620**	**580**	**220**	**380**	**200**	**1700**	-	**200**	**250**	-	-
TDS (mg/L)	**280**	**300**	**120**	**470**	**150**	**140**	-	**56**	**88**	-	-
Turbidity (NTU)	**230**	**210**	**92**	**120**	**76**	**290**	-	**78**	**70**	-	-
TVS (mg/L)	R[1]	R[1]	R[1]	R[1]	R[1]	R[1]	-	R[1]	R[1]	-	-
BACTERIA (mpn/100ml)											
Fecal Coliform	**50000J**	-	**>160000J**	**50000J**	**>160000J**	**50000J**	**30000J**	**50000J**	**90000J**	**3000J**	**800J**
Fecal Enterococci	**13600**	-	**10160**	**8420**	**18480**	**13210**	**11020**	**7520**	**10240**	**820**	**720**
Total Coliform	**>160000J**	-	**>160000J**	**>160000J**	**>160000J**	**>160000J**	**>160000J**	**>160000J**	**>160000J**	**3000J**	**1300J**

Bolded values indicate results that were greater than the reporting detection limit.

R[1] Indicates data were not valid. Data were rejected.

\- Analyte not tested

FD Field Duplicate

Table 6.2. Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 2 of 5)

ANALYTE	Belmont Pump 1	Belmont Pump 1FD	Belmont Pump 2	Bouton Creek 1	Bouton Creek 2	Los Cerritos Channel 1	Los Cerritos Channel 1FD	Los Cerritos Channel 2	Los Cerritos Channel 2FD	Alamitos Bay 1	Alamitos Bay 2
	12 Nov '01	12 Nov '01	24 Nov '01	13 Nov '01	24 Nov '01	12 Nov '01	12 Nov '01	24 Nov '01	24 Nov '01	12 Nov '01	24 Nov '01
TOTAL METALS (ug/L)											
Aluminum	**4200**	**4000**	**1600**	**2600**	**1400**	**4800**	-	**1400**	**1400**	-	-
Antimony	**2.3**	**2.6**	**1.6J**	**4.4**	**5.4J**	**5.1**	-	**2.2J**	**2.9J**	-	-
Arsenic	**4.8**	**4.7**	**3.0**	**3.4**	**2.5**	**9.7**	-	**2.9**	**3.1**	-	-
Beryllium	0.50U	0.50U	0.50U	0.50U	0.50U	0.50U	-	0.50U	0.50U	-	-
Cadmium	**2.80**	**2.70**	**1.30**	**1.80**	**1.30**	**5.50**	-	**1.60**	**1.70**	-	-
Chromium	**12**	**15**	**3.1**	**9.6**	**3.5**	**25**	-	**2.8**	**3.1**	-	-
Hex Chromium	0.02U	0.02U	0.02U	0.02U	0.02U	0.02U		0.02U	0.02U	-	-
Copper	**120**	**120**	**53**	**83**	**41**	**90**	-	**36**	**40**	-	-
Iron	**5000**	**5500**	**360J**	**3100**	**1700J**	**11000**	-	**1900J**	**1900J**	-	-
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U	-	0.20U	0.20U	-	-
Nickel	**25**	**23**	**9.9**	**16**	**9.3**	**28**	-	**8.8**	**9.0**	-	-
Lead	**150**	**190**	**59**	**88**	**45**	**370**	-	**43**	**46**	-	-
Selenium	1.0U	1.0U	1.0U	**1.2**	**1.8**	1.0U	-	1.0U	**2.0**	-	-
Silver	0.25U	0.25U	0.25U	0.76	0.25U	0.25U	-	0.25U	0.25U	-	-
Thallium	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	-	1.0U	1.0U	-	-
Zinc	**830**	**820**	**720**	**710**	**760**	**1500**	-	**770**	**780**	-	-
DISSOLVED METALS (ug/L)											
Aluminum	**53**	**46**	**25**	**48**	**64**	**210**	-	**110**	**110**	-	-
Antimony	**2.5**	**2.2**	**1.3**	**1.7**	**1.3**	**2.1**	-	**1.0**	**0.98**	-	-
Arsenic	**1.9**	**1.8**	**1.2**	**1.3**	**1.1**	**1.9**	-	**1.2**	**1.1**	-	-
Beryllium	0.50U	0.50U	0.50U	0.50U	0.50U	0.50U	-	0.50U	0.50U	-	-
Cadmium	**0.28**	**0.28**	0.25U	0.25U	0.25U	0.25U	-	0.25U	0.25U	-	-
Chromium	**1.0**	**0.91**	0.50U	1.2U	**0.69**	**1.3**	-	**0.79**	**0.71**	-	-
Copper	**9.5**	**9.3**	**6.8**	**10**	**10**	**7.4**	-	**7.9**	**7.4**	-	-
Iron	50U	50U	**360**	50U	**300**	**94**	-	**110**	**160**	-	-
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U	-	0.20U	0.20U	-	-
Nickel	**8.7**	**8.5**	**3.7**	**6.4**	**4.1**	**6.3**	-	3.3U	3.0U	-	-
Lead	**2.7**	**2.5**	**1.7**	**3.6**	**2.7**	**3.1**	-	**1.7**	**1.6**	-	-
Selenium	1.0U	1.0U	1.0U	1.0U	**1.4**	1.0U	-	1.0U	1.0U	-	-
Silver	0.25U	0.25U	0.25U	0.25U	0.25U	0.25U	-	0.25U	0.25U	-	-
Thallium	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	-	1.0U	1.0U	-	-
Zinc	**49**	**48**	**44**	**91**	**72**	**48**	-	**78**	**65**	-	-

Bolded values indicate results that were greater than the reporting detection limit.

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\- Analyte not tested.

FD Field Duplicate

Table 6.2. Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 3 of 5)

ANALYTE	Belmont Pump 1	Belmont Pump 1FD	Belmont Pump 2	Bouton Creek 1	Bouton Creek 2	Los Cerritos Channel 1	Los Cerritos Channel 1FD	Los Cerritos Channel 2	Los Cerritos Channel 2FD	Alamitos Bay 1	Alamitos Bay 2
	12 Nov '01	12 Nov '01	24 Nov '01	13 Nov '01	24 Nov '01	12 Nov '01	12 Nov '01	24 Nov '01	24 Nov '01	12 Nov '01	24 Nov '01
CHLORINATED PESTICIDES (ug/L)											
4,4'-DDD	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	-	0.05U	0.05U	-	-
4,4'-DDE	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	-	0.05U	0.05U	-	-
4,4'-DDT	0.01U	0.01U	**0.04**	0.01U	**0.05**	0.01U	-	0.01U	0.01U	-	-
Aldrin	0.005U	0.005U	**0.066**	0.005U	**0.042**	0.005U	-	**0.071**	**0.079**	-	-
alpha-BHC	0.05U	0.05U	0.05U	0.05U	0.07	0.05U	-	0.05U	0.05U	-	-
alpha-Chlordane	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	-	0.5U	0.5U	-	-
alpha-Endosulfan	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	-	0.05U	0.05U	-	-
beta-BHC	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	-	0.05U	0.05U	-	-
beta-Endosulfan	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	-	0.05U	0.05U	-	-
Delta-BHC	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	-	0.05U	0.05U	-	-
Endosulfan Sulfate	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	-	0.05U	0.05U	-	-
Endrin	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U	-	0.01U	0.01U	-	-
Endrin Aldehyde	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U	-	0.01U	0.01U	-	-
gamma-BHC (lindane)	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	-	0.05U	0.05U	-	-
gamma-Chlordane	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	-	0.5U	0.5U	-	-
Heptachlor	0.010U	0.010U	0.010U	0.010U	0.010U	0.010U	-	0.012	0.011	-	-
Heptachlor Epoxide	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U	-	0.01U	0.01U	-	-
Total PCBs	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	-	1.0U	1.0U	-	-
Toxaphene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
AROCLORS (ug/L)											
Arochlor 1016	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Arochlor 1221	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Arochlor 1232	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Arochlor 1242	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Arochlor 1248	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Arochlor 1254	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Arochlor 1260	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
ORGANOPHOSPHATE PESTICIDES (ug/L)											
Atrazine	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Dursban(chlorpyrifos)	**0.13**	**0.07**	0.05U	**0.17**	0.05U	0.05U	-	**0.28**	**0.31**	-	-
Cyanazine	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Diazinon	**3.0**	**2.4**	**0.92**	**0.43**	**0.42**	0.01U	-	**0.41**	**0.35**	-	-
Malathion	**1.1**	**1.3**	**1.4**	1.0U	1.0U	1.0U	-	1.0U	1.0U	-	-
Prometryn	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Simazine	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-

Bolded values indicate results that were greater than the reporting detection limit.

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\- Analyte not tested.

FD Field Duplicate

Table 6.2. Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 4 of 5)

ANALYTE	Belmont Pump 1	Belmont Pump 1FD	Belmont Pump 2	Bouton Creek 1	Bouton Creek 2	Los Cerritos Channel 1	Los Cerritos Channel 1FD	Los Cerritos Channel 2	Los Cerritos Channel 2FD	Alamitos Bay 1	Alamitos Bay 2
	12 Nov '01	12 Nov '01	24 Nov '01	13 Nov '01	24 Nov '01	12 Nov '01	12 Nov '01	24 Nov '01	24 Nov '01	12 Nov '01	24 Nov '01
HERBICIDES (ug/L)											
2,4,5-TP (Silvex)	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	-	0.5U	0.5U	-	-
2,4-D	4UJ	4UJ	1UJ	4UJ	1UJ	4UJ	-	1UJ	1UJ	-	-
Glyphosate	5U	5U	5UJ	5U	5UJ	5U	-	5UJ	5UJ	-	-
SEMIVOLATILES (ug/L)											
1,2,4-Trichlorobenzene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
1,2-Dichlorobenzene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
1,2-Diphenylhydrazine	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
1,3-Dichlorobenzene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
1,4-Dichlorobenzene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
2,4,6-Trichlorophenol	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
2,4-Dichlorophenol	2U	2U	2U	2U	2U	2U	-	2U	2U	-	-
2,4-Dimethylphenol	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
2,4-Dinitrophenol	5.0U	5.0U	5.0U	5.0U	**5.2**	5.0U	-	**5.5**	**7.1**	-	-
2,4-Dinitrotoluene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
2,6-Dinitrotoluene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
2-Chloroethylvinyl ether	-	-	-	-	-	-	-	-	-	-	-
2-Chloronaphthalene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
2-Chlorophenol	2U	2U	2U	2U	2U	2U	-	2U	2U	-	-
2-Nitrophenol	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
3,3'-Dichlorobenzidine	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
4,6 Dinitro-2-methylphenol	2U	2U	5U	2U	5U	2U	-	5U	5U	-	-
4-Bromophenyl Phenyl Ether	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
4-Chloro-3-methylphenol	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
4-Chlorophenyl Phenyl Ether	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
4-Nitrophenol	**1.5**	**1.8**	5.0U	**1.9**	**6.6**	1.0U	-	**5.9**	**6.3**	-	-
Acenaphthene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Acenaphthylene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Anthracene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Benzidine	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Benzo(a)Anthracene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Benzo(a)Pyrene	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-

Bolded values indicate results that were greater than the reporting detection limit.
R[1] Indicates data were not valid. Data were rejected.
\- Analyte not tested.

Table 6.2 Stormwater Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 5 of 5)

ANALYTE	Belmont Pump 1	Belmont Pump 1FD	Belmont Pump 2	Bouton Creek 1	Bouton Creek 2	Los Cerritos Channel 1	Los Cerritos Channel 1FD	Los Cerritos Channel 2	Los Cerritos Channel 2FD	Alamitos Bay 1	Alamitos Bay 2
	12 Nov '01	12 Nov '01	24 Nov '01	13 Nov '01	24 Nov '01	12 Nov '01	12 Nov '01	24 Nov '01	24 Nov '01	12 Nov '01	24 Nov '01
SEMI-VOLATILES (ug/L)											
Benzo(b)Fluoranthene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Benzo(ghi)Perylene	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
Benzo(k)Fluoranthene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Bis(2-chloroethoxy)Methane	2U	2U	10U	2U	10U	2U	-	10U	10U	-	-
Bis(2-chloroethyl)Ether	1U	1U	10U	1U	10U	1U	-	10U	10U	-	-
Bis(2-chloroisopropyl)Ether	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
Bis(2-Ethylhexyl)Phthalate	1.0U	1.0U	**8.0**	1.0U	**10**	1.0U	-	**8.8**	**9.4**	-	-
Butylbenzyl Phthalate	1.0 U	1.0U	**1.1**	1.0U	**1.7**	1.0 U	-	**1.2**	**1.6**	-	-
Chrysene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Dibenzo(a,h)Anthracene	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
Dieldrin	0.01U	0.01U	0.01U	0.01U	0.01U	0.01U	-	**0.13**	0.01U	-	-
Diethyl Phthalate	1U	1U	4U	1U	4U	1U	-	4U	4U	-	-
Dimethyl Phthalate	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Di-n-Butyl Phthalate	**2.4**	**1.6**	4.0U	1.3UJ	4.0U	**2.3**	-	4.0U	4.0U	-	-
Di-n-Octyl Phthalate	1.0U	1.0U	**1.7**	**1.1**	**4.5**	1.0U	-	**4.4**	**4.5**	-	-
Fluoranthene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Fluorene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Hexachlorobenzene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Hexachlorobutadiene	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
Hexachlorocyclopentadiene	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
Hexachloroethane	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
Indeno(1,2,3-c,d)Pyrene	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
Isophorone	1U	1U	5U	1U	5U	1U	-	5U	5U	-	-
Naphthalene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Nitrobenzene	1U	1U	5U	1U	5U	1U	-	5U	5U	-	-
N-Nitrosodimethylamine	-	-	-	-	-	-	-	-	-	-	-
N-Nitrosodi-n-Propylamine	5U	5U	10U	5U	10U	5U	-	10U	10U	-	-
N-Nitrosodiphenylamine	1U	1U	2U	1U	2U	1U	-	2U	2U	-	-
Pentachlorophenol	1.0U	**1.5**	**8.3**	1.0U	5.0U	1.0U	-	5.0U	5.0U	-	-
Phenanthrene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Pyrene	1U	1U	1U	1U	1U	1U	-	1U	1U	-	-
Phenol	1U	1U	2.0U	1U	2.0U	**5.7**	-	2.0U	2.0U	-	-

Bolded values indicate results that were greater than the reporting detection limit.

R[1] Indicates data were not valid. Data were rejected.

\- Analyte not tested.

Table 6.3. Monitored Dry Weather Events, 1999-2002

Station	Event 1 10 Apr. '00	Event 2 21 Jun. '00	Event 3 29 Jun. '00	Event 4 5 Jun.'01	Event 5 16 Aug 01	Event 6 9,14 May 02
Bouton Creek		X	X	X	X	X
Belmont Pump		X	X	X	X	X
Los Cerritos Channel				X	X	X
Dominguez Gap		X[1]	X[1]	X[1]	X[1]	X[1]
Alamitos Bay	X	X	X	X	X	X

1 Intake to basin was observed to be dry. Therefore, no samples were collected.
Shading indicates 2001/2002 Dry Weather Surveys included in this report. Data from Event 5 reported in earlier letter report that is included as Appendix F. Summary data from this event are included in the data tables.

Table 6.4. Dry and Wet Weather Bacteria Results for Alamitos Bay Receiving Waters (2001/2002)

Date	16 Aug '01[2]	12 Nov '01[1]	24 Nov '01[1]	9 May '02[2]
Total Coliform	11	3000J	1300J	240
Fecal Coliform	4	3000J	800J	7
Fecal Enterococci	1.0U[3]	820	720	10

1. Wet weather sampling event. Data also included in Table 6.3 for comparison with stormwater monitoring sites.
2. Dry weather sampling event.
3. Fecal Streptococci was measured during the 16 Aug 2001 survey. Analytical requirements were changed to enterococci for all subsequent events.

Table 6.5. Field Measurements for Bouton Creek, Belmont Pump, and Los Cerritos Channel, Dry Weather Season (2001/2002).

	Bouton Creek		Belmont Pump		Los Cerritos	
Date	**8/16/01**	**5/14/02**	**8/16/01**	**5/9/02**	**8/16/01**	**5/9/02**
Time	**02:00**	**07:30**	**06:40**	**07:20**	**05:35**	**05:00**
Temperature (^{0}C)	20.8	17.0	21.8	16.1	19.9	13.9
pH	8.15	8.41	8.45	8.39	8.17	8.72
Conductivity (mmho/cm)	7.17	9.57	2.63	2.21	0.84	0.66
Flow (cfs)	1.48[1]	0.15[3]	0..086[4]	1.82[4]	3.55[1]	2.75[1]
Dissolved Oxygen (mg/L)	2.27[2]	9	5.17	11	2.77	9

1. Flow was determined by measuring the depth and width of the water channel, as well as the velocity of a floating object in the water.
2. Value based on 100% saturation conditions, measured temperature and salinity values.
3. The flow rate was determined with the KLASS flow meter installed at the station.
4. The flow rate was determined by observing changes in water level in the sump area over a 24-hour period.

Table 6.6. Dry Weather Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 1 of 5)

ANALYTE	Belmont Pump	Los Cerritos Channel	Bouton Creek	Bouton Creek FD	Alamitos Bay	Alamitos Bay	Belmont Pump	Los Cerritos Channel	Bouton Creek	Bouton Creek FD
	16 Aug '01	16 Aug '01	16 Aug '01	16 Aug '01	16 Aug '01	9 May '02	9 May '02	9 May '02	14 May '02	14 May '02
CONVENTIONALS										
Biochemical Oxygen Demand (mg/L)	5.0U	**27J**	**26J**	**21J**	-	-	10U	**18**	10U	10U
Chemical Oxygen Demand (mg/L)	**180**	**210**	**100**	**760**	-	-	**220**	**100**	**440**	**390**
Total Organic Carbon (mg/L)	11U	13U	15U	12U	-	-	**8**	**24**	**18**	**20**
Specific Conductance (umhos/cm)	**2800**	**840**	**7800**	**7700**	-	-	**2700**	**650**	**12000**	**12000**
Total Hardness (mg/L)	**350**	**170**	**890**	**910**	-	-	**330**	**130**	**1300**	**1300**
Alkalinity, as CaCO3 (mg/L)	**440**	**150**	**140**	**140**	-	-	**380**	**120**	**170**	**170**
pH (units)	**8.4**	**8.6**	**7.8**	**8.0**	-	-	8.41	9.66	7.71	7.72
Cyanide (ug/L)	5.0U	5.0U	5.0U	5.0U	-	-	5UJ	5UJ	5UJ	5UJ
Chloride (mg/L)	**560**	**120**	**2500**	**2700**	-	-	**570**	**83**	**4200**	**4000**
Fluoride (mg/L)	**1.6**	**0.69**	**0.9**	**0.91**	-	-	**1.7**	**0.76**	**1.7**	**1.4**
Total Kjeldahl Nitrogen (mg/L)	**0.90**	**1.8**	**4.1**	**1.8**	-	-	**0.89J**	**1.8J**	**1.5**	**1.7**
Total Ammonia-Nitrogen (mg/L)	**0.13**	**0.58**	**0.11**	**0.23**	-	-	**0.11**	**0.15**	0.1U	0.1U
Nitrite Nitrogen (mg/L)	0.2U	0.2U	0.2U	0.2U	-	-	0.2U	0.1U	1U	1U
Nitrate Nitrogen (mg/L)	**1.3**	**0.068**	0.01U	0.01U	-	-	**1.2**	0.1U	1U	1U
Total Nitrogen	**2.3**	**2.0**	**4.2**	**1.9**	-	-	**2.19**	**2**	**2.6**	**2.8**
Total Phosphorus (mg/L)	**0.86**	**0.12**	**0.36**	**0.11**	-	-	**0.86**	**0.17**	**0.11**	**0.13**
Dissolved Phosphorus (mg/L)	**0.87**	**0.046**	**0.025**	**0.029**	-	-	**0.96**	**0.046**	**0.031**	**0.031**
MBAS (mg/L)	**0.046**	**0.054**	**0.064**	**0.040**	-	-	**0.037**	0.02U	**0.037**	**0.033**
MTBE (ug/L)	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	0.5U	0.5U
Total Phenols (mg/L)	0.1U	0.1U	0.1U	0.1U	-	-	0.1UJ	0.1UJ	0.1UJ	0.1UJ
Oil & Grease (mg/L)	5.0U	-	5.0U	5.0U	-	-	5U	5U	5U	5U
TRPH (mg/L)	5.0U	5.0U	5.0U	5.0U	-	-	5U	5U	5U	5U
Total Suspended Solids (mg/L)	1.0U	**58**	**10**	**10**	-	-	**2**	**2**	1U	1U
Total Dissolved Solids (mg/L)	**1800**	**600**	**5100**	**5100**	-	-	**1600**	**430**	**7400**	**7400**
Turbidity (NTU)	**11**	**36**	**10**	**9.2**	-	-	**1.8**	**4.9**	**2.5**	**2.6**
Total Volatile Solids (mg/L)	1.0U	1.0U	1.0U	1.0U	-	-	R[1]	R[1]	R[1]	R[1]
BACTERIA (mpn/100ml)										
Fecal Coliform	**2,300**	**2300**	**230**	**2300**	**4**	**7**	**2400**	**1100**	**170**	**300**
Fecal Enterococci	-	-	-	-	-	**10**	**1760**	**910**	**1720**	**910**
Total Coliform	**8,000**	**30,000**	**3,000**	**2300**	**11**	**240**	**90000**	**3000**	**17000**	**5000**

Bolded values indicate results that were greater than the reporting detection limit.
R[1] Indicates data were not valid. Data were rejected.
\- Analyte not tested
FD Field Duplicate

Table 6.6. Dry Weather Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 2 of 5)

ANALYTE	Belmont Pump	Los Cerritos Channel	Bouton Creek	Bouton Creek FD	Alamitos Bay	Alamitos Bay	Belmont Pump	Los Cerritos Channel	Bouton Creek	Bouton Creek FD
	16 Aug '01	16 Aug '01	16 Aug '01	16 Aug '01	16 Aug '01	9 May '02	9 May '02	9 May '02	14 May '02	14 May '02
TOTAL METALS (ug/L)										
Aluminum	**140**	**97**	**84**	**88**	-	-	**31**	**25**	**39**	**29**
Antimony	-	-	-	-	-	-	**0.6**	**3.7**	**1.1**	**1**
Arsenic	3.9U	1.2U	1.8U	1.6U	-	-	**3.3**	**7**	0.5U	0.5U
Beryllium	0.50U	0.50U	0.50U	0.50U	-	-	0.5U	0.5U	0.5U	0.5U
Cadmium	0.25U	**0.57**	0.25U	0.25U	-	-	0.25U	**0.36**	0.25U	0.25U
Chromium	**2.5**	**1.5**	**2.4**	**2.4**	-	-	**51**	**15**	**41**	**36**
Hexavalent Chromium	**4.91J**	**6.20**	**4.91J**	**5.43**	-	-	0.02U	0.02U	0.02U	0.02U
Copper	4.8U	**17**	**15**	**16**	-	-	**5.4**	**22**	**11**	**10**
Iron	**330**	**320**	**220**	**220**	-	-	**100J**	50UJ	**310J**	**280J**
Mercury	0.20U	**3.5**	0.20U	0.20U	-	-	0.2U	0.2U	0.2U	0.2U
Nickel	**5.6**	**7.5**	**5.0**	**5.2**	-	-	**2.6**	**3.5**	**6.3**	**5.6**
Lead	**0.99**	**3.5**	**3**	**3.5**	-	-	**0.68**	**0.78**	**1.7**	**1.6**
Selenium	-	-	-	-	-	-	**2.5**	**2.2**	**4.7**	**2.7**
Silver	-	-	-	-	-	-	0.25U	**0.62**	**0.56**	0.25U
Thallium	-	-	-	-	-	-	1U	1U	1U	1U
Zinc	**13**	**43**	**21**	**23**	-	-	**19**	**17**	**41**	**39**
DISSOLVED METALS (ug/L)										
Aluminum	**140**	**88**	**80**	**75**	-	-	25U	25U	25U	25U
Antimony	-	-	-	-	-	-	0.5U	**1.2**	**0.7**	**0.7**
Arsenic	3.9U	1.1U	1.5U	1.6U	-	-	**2.3**	**4.7**	0.5U	0.5U
Beryllium	0.5U	0.5U	0.5U	0.5U	-	-	0.5U	0.5U	0.5U	0.5U
Cadmium	0.25U	0.5	0.25U	0.25U	-	-	0.25U	0.25U	0.25U	0.25U
Chromium	**2.4**	**1.3**	**2.4**	**2.1**	-	-	**39**	**8.8**	**22**	**22**
Copper	**4.8**	**16**	**15**	**14**	-	-	**3.8**	**16**	**6.7**	**6.7**
Iron	**50**	**40**	**60**	**70**	-	-	**110**	50U	**210**	**220**
Mercury	0.2U	0.2U	0.2U	0.2U	-	-	0.2U	0.2U	0.2U	0.2U
Nickel	**5.4**	**7.2**	**4.9**	**5.1**	-	-	**1.6**	**2.5**	**3.9**	**3.8**
Lead	**0.97**	**3.2**	**2.9**	**3**	-	-	0.5U	0.5U	0.5U	0.5U
Selenium	-	-	-	-	-	-	**1.9**	**1.1**	**4.2**	1U
Silver	-	-	-	-	-	-	0.25U	0.25U	0.25U	0.25U
Thallium	-	-	-	-	-	-	1U	1U	1U	1U
Zinc	**13**	**39**	**21**	**20**	-	-	**12**	**9.3**	**23**	**26**

Bolded values indicate results that were greater than the reporting detection limit.
R[1] Indicates data were not valid. Data were rejected.
\- Analyte not tested
FD Field Duplicate.

Table 6.6. Dry Weather Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 3 of 5)

ANALYTE	Belmont Pump	Los Cerritos Channel	Bouton Creek	Bouton Creek FD	Alamitos Bay	Alamitos Bay	Belmont Pump	Los Cerritos Channel	Bouton Creek	Bouton Creek FD
	16 Aug '01	16 Aug '01	16 Aug '01	16 Aug '01	16 Aug '01	9 May '02	9 May '02	9 May '02	14 May '02	14 May '02
CHLORINATED PESTICIDES (ug/L)										
4,4'-DDD	0.5U	0.05U	0.05U	0.05U	-	-	0.05U	0.05U	0.05U	0.05U
4,4'-DDE	0.05U	0.05U	0.05U	0.05U	-	-	0.05U	0.05U	0.05U	0.05U
4,4'-DDT	0.05U	0.01U	0.01U	0.01U	-	-	0.01U	0.01U	0.01U	0.01U
Aldrin	0.005U	0.005U	0.005U	0.005U	-	-	0.005U	0.005U	0.005U	0.005U
alpha-BHC	0.05U	0.05U	0.05U	0.05U	-	-	0.01U	0.01U	0.01U	0.01U
alpha-Chlordane	0.5U	0.5U	0.5U	0.5U	-	-	0.1U	0.1U	0.1U	0.1U
alpha-Endosulfan	0.05U	0.05U	0.05U	0.05U	-	-	0.02U	0.02U	0.02U	0.02U
beta-BHC	0.05U	0.05U	0.05U	0.05U	-	-	0.005U	0.005U	0.005U	0.005U
beta-Endosulfan	0.05U	0.05U	0.05U	0.05U	-	-	0.01U	0.01U	0.01U	0.01U
delta-BHC	0.05U	0.05U	0.05U	0.05U	-	-	0.005U	0.005U	**0.019**	**0.021**
Endosulfan Sulfate	0.05U	0.05U	0.05U	0.05U	-	-	0.05U	0.05U	0.05U	0.05U
Endrin	0.01U	0.01U	0.01U	0.01U	-	-	0.01U	0.01U	0.01U	0.01U
Endrin Aldehyde	0.01U	0.01U	0.01U	0.01U	-	-	0.01U	0.01U	0.01U	0.01U
gamma-BHC (lindane)	0.05U	0.05U	0.05U	0.05U	-	-	0.01U	0.01U	0.01U	0.01U
gamma-Chlordane	0.5U	0.5U	0.5U	0.5U	-	-	0.02U	0.02U	0.02U	0.02U
Heptachlor	0.01U	0.01U	0.01U	0.01U	-	-	0.1U	0.1U	0.1U	0.1U
Heptachlor Epoxide	0.01U	0.01U	0.01U	0.01U	-	-	0.01U	0.01U	0.01U	0.01U
Total PCBs	1.0U	1.0U	1.0U	1.0U	-	-	0.01U	0.01U	0.01U	0.01U
Toxaphene	0.5U	0.5U	0.5U	0.5U	-	-	0.5U	0.5U	0.5U	0.5U
AROCLORS (ug/L)										
Arochlor 1016	1.0U	1.0U	1.0U	1.0U	-	-	0.5U	0.5U	0.5U	0.5U
Arochlor 1221	1.0U	1.0U	1.0U	1.0U	-	-	0.5U	0.5U	0.5U	0.5U
Arochlor 1232	1.0U	1.0U	1.0U	1.0U	-	-	0.5U	0.5U	0.5U	0.5U
Arochlor 1242	1.0U	1.0U	1.0U	1.0U	-	-	0.5U	0.5U	0.5U	0.5U
Arochlor 1248	1.0U	1.0U	1.0U	1.0U	-	-	0.5U	0.5U	0.5U	0.5U
Arochlor 1254	1.0U	1.0U	1.0U	1.0U	-	-	0.5U	0.5U	0.5U	0.5U
Arochlor 1260	1.0U	1.0U	1.0U	1.0U	-	-	0.5U	0.5U	0.5U	0.5U
Atrazine	1.0U	1.0U	1.0U	1.0U	-	-	2U	2U	2U	2U
Dursban (chlorpyrifos)	0.05U	0.05U	0.05U	0.05U	-	-	0.05U	0.05U	0.05U	0.05U
Cyanazine	1.0U	1.0U	1.0U	1.0U	-	-	2U	2U	2U	2U
Diazinon	**0.22**	**0.096**	**0.15**	**0.15**	-	-	**0.12**	**0.32**	**0.33**	**0.34**
Malathion	0.1U	0.1U	0.1U	0.1U	-	-	1U	1U	1U	1U
Prometryn	1.0U	1.0U	1.0U	1.0U	-	-	2U	2U	2U	2U
Simazine	1.0U	1.0U	1.0U	1.0U	-	-	2U	2U	2U	2U

Bolded values indicate results that were greater than the reporting detection limit.
R[1] Indicates data were not valid. Data were rejected.
\- Analyte not tested
FD Field Duplicate.

Table 6.6. Dry Weather Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 4 of 5)

ANALYTE	Belmont Pump 16 Aug '01	Los Cerritos Channel 16 Aug '01	Bouton Creek 16 Aug '01	Bouton Creek FD 16 Aug '01	Alamitos Bay 16 Aug '01	Alamitos Bay 9 May '02	Belmont Pump 9 May '02	Los Cerritos Channel 9 May '02	Bouton Creek 14 May '02	Bouton Creek FD 14 May '02
HERBICIDES (ug/L)										
2,4,5-TP (Silvex)	0.5U	0.5U	0.5U	0.5U	-	-	0.5U	0.5U	0.5U	0.5U
2,4-D	1U	1U	1U	1.0U	-	-	**1.2**	**5.5**	**3**	**3**
Glyphosate	5U	5U	5U	5.0U	-	-	5UJ	5UJ	5UJ	5UJ
SEMI-VOLATILES (ug/L)										
1,2,4-Trichlorobenzene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
1,2-Dichlorobenzene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
1,2-Diphenylhydrazine	3.0U	3.0U	0.5U	3.0U	-	-	1U	1U	1U	1U
1,3-Dichlorobenzene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
1,4-Dichlorobenzene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
2,4,6-Trichlorophenol	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
2,4-Dichlorophenol	2.0U	2.0U	2.0U	2.0U	-	-	2U	2U	2U	2U
2,4-Dimethylphenol	2.0U	2.0U	2.0U	2.0U	-	-	1U	1U	1U	1U
2,4-Dinitrophenol	3.0U	3.0U	3.0U	3.0U	-	-	5U	5U	5U	5U
2,4-Dinitrotoluene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
2,6-Dinitrotoluene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
2-Chloroethylvinyl ether	-	-	-	-	-	-	-	-	-	-
2-Chloronaphthalene	-	-	-	-	-	-	1U	1U	1U	1U
2-Chlorophenol	2.0U	2.0U	2.0U	2.0U	-	-	2U	2U	2U	2U
2-Nitrophenol	3.0U	3.0U	3.0U	3.0U	-	-	1U	1U	1U	1U
3,3'-Dichlorobenzidine	3.0U	3.0U	3.0U	3.0U	-	-	1U	1U	1U	1U
4,6 Dinitro-2-methylphenol	3.0U	3.0U	3.0U	3.0U	-	-	2U	2U	2U	2U
4-Bromophenyl Phenyl Ether	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
4-Chloro-3-methylphenol	3.0U	3.0U	3.0U	3.0U	-	-	1U	1U	1U	1U
4-Chlorophenyl Phenyl Ether	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
4-Nitrophenol	3.0U	3.0U	3.0U	3.0U	-	-	1U	1U	1U	1U
Acenaphthene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
Acenaphthylene	0.2U	0.2U	0.2U	0.2U	-	-	1U	1U	1U	1U
Anthracene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
Benzidine	3.0U	3.0U	3.0U	3.0U	-	-	1U	1U	1U	1U
Benzo(a)Anthracene	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
Benzo(a)Pyrene	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
Benzo(b)Fluoranthene	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
Benzo(ghi)Perylene	-	-	-	-	-	-	1U	1U	1U	1U
Benzo(k)Fluoranthene	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U

Bolded values indicate results that were greater than the reporting detection limit.
R[1] Indicates data were not valid. Data were rejected.
\- Analyte not tested
FD Field Duplicate.

Table 6.6. Dry Weather Chemistry Results: City of Long Beach Storm Monitoring Project. (Page 5 of 5)

ANALYTE	Belmont Pump	Los Cerritos Channel	Bouton Creek	Bouton Creek FD	Alamitos Bay	Alamitos Bay	Belmont Pump	Los Cerritos Channel	Bouton Creek	Bouton Creek FD
	16 Aug '01	16 Aug '01	16 Aug '01	16 Aug '01	16 Aug '01	9 May '02	9 May '02	9 May '02	14 May '02	14 May '02
SEMIVOLATILES (ug/L)										
Bis(2-chloroethoxy)Methane	1.0U	1.0U	1.0U	1.0U	-	-	2U	2U	2U	2U
Bis(2-chloroethyl)Ether	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
Bis(2-chloroisopropyl)Ether	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
Bis(2-Ethylhexyl)Phthalate	**3.1**	**15.8**	**8.9**	**10.7**	-	-	1U	1U	1U	1U
Butylbenzyl Phthalate	-	-	-	-	-	-	1U	1U	1U	1U
Chrysene	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
Dibenzo(a,h)Anthracene	-	-	-	-	-	-	0.1U	0.1U	0.2U	0.2U
Dieldrin	0.01U	0.01U	0.01U	0.01U	-	-	1U	1U	1U	1U
Diethyl Phthalate	0.5U	**0.8**	**0.9**	0.5U	-	-	1U	1U	1U	1U
Dimethyl Phthalate	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
Di-n-Butyl Phthalate	3.0U	**6.0**	3.0U	**3.1**	-	-	1U	1U	1U	1U
Di-n-Octyl Phthalate	3.0U	3.0U	**3.8**	**3.1**	-	-	0.05U	0.05U	0.05U	0.05U
Fluoranthene	1.0U	1.0U	1.0U	1.0U	-	-	0.1U	0.1U	0.1U	0.1U
Fluorene	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
Hexachlorobenzene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
Hexachlorobutadiene	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
Hexachlorocyclopentadiene	3.0U	3.0U	3.0U	3.0U	-	-	1U	1U	1U	1U
Hexachloroethane	1.0U	1.0U	1.0U	1.0U	-	-	1U	1U	1U	1U
Indeno(1,2,3-c,d)Pyrene	1.0U	1.0U	1.0U	1.0U	-	-	0.05U	0.05U	0.2U	0.2U
Isophorone	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
Naphthalene	0.5U	0.5U	0.5U	0.5U	-	-	0.2U	0.2U	0.2U	0.2U
Nitrobenzene	0.5U	0.5U	0.5U	0.5U	-	-	1U	1U	1U	1U
N-Nitrosodimethylamine	3.0U	3.0U	3.0U	3.0U	-	-	1U	1U	1U	1U
N-Nitrosodi-n-Propylamine	1.0U	1.0U	1.0U	1.0U	-	-	5U	5U	5U	5U
N-Nitrosodiphenylamine	3.0U	3.0U	3.0U	3.0U	-	-	1U	1U	1U	1U
Pentachlorophenol	2.0U	3.0U	2.0U	2.0U	-	-	1U	1U	1U	1U
Phenanthrene	0.5U	0.5U	0.5U	0.5U	-	-	0.05U	0.05U	0.05U	0.05U
Pyrene	0.5U	0.5U	0.5U	0.5U	-	-	0.1U	0.1U	0.1U	0.1U
Phenol	1.0U	1.0U	1.0U	1.0U	-	-	0.05U	0.05U	0.05U	0.05U

Bolded values indicate results that were greater than the reporting detection limit.
R[1] Indicates data were not valid. Data were rejected.
\- Analyte not tested
FD Field Duplicate.

7.0 TOXICITY RESULTS

Toxicity tests were conducted on subsamples of the composites collected for chemical analysis. Wet weather samples were collected from two storm events: November 12-13, 2001 and November 24, 2001. Dry weather sampling occurred on May 9, 2002, with a resampling of one station on May 24, 2002.

7.1 Wet Weather Discharge

7.1.1 Belmont Pump

Composite samples were collected from the Belmont pump station during separate storm events and were tested with three species, the water flea (freshwater crustacean), mysid (marine crustacean), and sea urchin (marine echinoderm). The first sample collected from this station this year was on November 12, 2001. This sample caused toxic effects to all three test species (Table 7.1), with the fertilization test being the most sensitive (Figure 7.1). Both the water flea survival and reproduction endpoints showed the presence of toxicity (Table 7.1), with the survival endpoint slightly more sensitive (Figure 7.1). Mysid survival, but not growth, was adversely affected by the sample.

The second sample was collected on November 24, 2001 and produced toxic responses in all three species. Again, the sea urchin fertilization test was the most sensitive indicator of toxicity with a 27.1% sample calculated to cause a 50% reduction in fertilization (Table 7.1). Significant reductions in water flea survival and reproduction were found at the 12% and 25% concentrations. Mysid survival and growth was significantly reduced at the 100% concentration. Water flea survival showed a greater degree of response than did the reproduction endpoint (Figure 7.1).

7.1.2. Bouton Creek

The first sample from the Bouton Creek station was collected on November 13, 2001. Toxicity to this sample was detected by all three test species (Table 7.2). Sea urchin egg fertilization was again the most sensitive test method, with 32 TUc (Figure 7.2).

The second Bouton Creek sample was collected on November 24, 2001 and caused a toxic response to both sea urchins and water fleas (Table 7.2 and Figure 7.2). The mysid test was not applied to this sample, in accordance with a modification to the monitoring plan approved by the LA Regional Water Quality Control Board.

7.1.3. Los Cerritos Channel

The first sample from the Los Cerritos Channel station was collected on November 12, 2001. This sample caused a toxic response to all three test species (Table 7.3 and Figure 7.3). The second Los Cerritos Channel sample was collected on November 24, 2001 and elicited a toxic response from the water flea survival and reproduction and sea urchin fertilization tests. The NOEC for the sea urchin test was 3% (Table 7.3) and much lower than the NOEC for the water flea test, indicating that the stormwater sample was approximately four times more toxic to the sea urchin than to the water flea. The mysid test was not used to test the second sample.

7.2. Receiving Water

Two grab samples of receiving water from Alamitos Bay were collected during storm events on November 12 and 24, 2001 (Table 7.4). Each sample was tested for toxicity to mysids and sea urchins. Since these samples were saline, the water flea test was not conducted. None of the samples caused toxic effects to mysid survival, mysid growth or sea urchin fertilization.

7.3 Toxicity Identification Evaluations (TIEs) of Stormwater

The trigger for performing a TIE was modified prior to the 2001/2002 wet season. A TIE was initiated when a LC50 of ≤100% (equivalent to ≥1 acute TU) was obtained for the water flea or mysid test, or an EC50 of ≤50% (≥2 acute TU) was obtained for the sea urchin fertilization test. This TIE trigger was exceeded 12 times among the tests conducted on the two wet weather samples (Table 7.5). Each of the three species had at least one exceedance of the TIE trigger.

For the first wet weather sampling event, TIEs were initiated on samples from all three sites for the water flea test, on the Belmont pump station sample for the mysid test, and on the Bouton Creek sample for the sea urchin test. A reduction in toxicity relative to the initial test result was obtained for both TIEs of the Bouton Creek sample, resulting in a baseline toxicity of less than 2 TU, which prompted termination of these TIEs. The TIE trigger was exceeded in all tests conducted with samples from the second storm event monitored (November 24, 2001). The TIE of the Bouton Creek sample with the water flea was again terminated due to a loss of toxicity in the baseline test results.

7.3.1 Belmont Pump Station

The results of the TIEs on samples from the Belmont pump station are summarized in Figure 7.4. Extraction of the November 12 sample using a C-18 column was highly effective in reducing toxicity in both the water flea and mysid tests. PBO treatment also eliminated the toxicity to the water flea. Increased toxicity was present in the blanks for the PBO, EDTA, and STS treatments used with the mysid test, and in the STS treatment with the water flea. The increase in toxicity of the Belmont pump sample obtained for these treatments (Figure 7.4) is an artifact of this toxicity and confounds the interpretation of this portion of the results. The consistent effectiveness of the C-18 treatment and elimination of toxicity obtained with the PBO treatment in the water flea tests suggest that a nonpolar organic, probably an organophosphate (OP) pesticide is a likely toxicant of concern in this sample.

Three TIEs were conducted on the November 24 Belmont Pump sample and the results yielded three distinct patterns of response. The water flea test results were similar to those obtained with the November 12 sample; toxicity was eliminated with the C-18 and PBO treatments, which suggested OP pesticide toxicity. The mysid TIE also indicated the presence of a nonpolar organic toxicant, but toxicity was increased following addition of PBO. This result suggests that the mysids were not responding to the toxic effects of OP pesticides. The addition of EDTA in the TIE using the sea urchin test eliminated all toxicity (Figure 7.4), indicating that a divalent metal was the likely toxicant to this species.

7.3.2. Bouton Creek Station

One TIE on stormwater from Bouton Creek was conducted; the November 24 sample was tested using the sea urchin fertilization test (Table 7.5). The TIE results obtained for this sample were similar to the results of the Belmont Pump tests using the sea urchin test, addition of EDTA eliminated the toxicity of the sample. Addition of STS, centrifugation, and extraction using a C-18 column did not have a substantial impact on the toxicity of this sample.

7.3.3 Los Cerritos Channel Station

TIEs were conducted on both stormwater samples from the Los Cerritos Channel. The November 12 and 24 samples were tested using the water flea and the results were similar to those obtained for the Belmont Pump station (Figure 7.6). Extraction using C-18 and addition of PBO eliminated the toxicity of both of the Los Cerritos Channel samples, again indicating the presence of OP pesticide toxicity. An indication of other types of toxicants was also present in these samples, however. EDTA was partially effective in reducing toxicity in the November 12 sample (suggesting metal toxicants) and centrifugation of the November 24 sample eliminated the toxicity, which indicated that the toxicants were associated with particles.

7.4 Dry Weather Discharge

Toxicity tests were conducted on samples from one sampling event on May 9, 2002. The Bouton Creek sample contained 13 g/kg salinity, which was more than the tolerance limit of the water flea. Bouton Creek was resampled on May 14 and a sample with an acceptable salinity of 7 g/kg was obtained and used for toxicity testing.

7.4.1 Belmont Pump Station

The Belmont Pump sample was not toxic to the water flea (Table 7.6). A significant amount of toxicity was detected with the sea urchin fertilization test, however. The Belmont Pump sample contained 4 TUc when assessed using the sea urchin test.

7.4.2 Bouton Creek

The Bouton Creek sample contained significant toxicity to the water flea (Table 7.6). Survival was significantly reduced at the 50% exposure concentration, and water flea reproduction was significantly inhibited by exposure to 12% of the Bouton Creek sample.

7.4.3 Los Cerritos Channel

The Los Cerritos dry weather sample was not toxic to the water flea. However, this sample produced significant toxicity to sea urchin sperm (Figure 7.7 and Table 7.6).

7.4.4 Alamitos Bay Receiving Water

The Alamitos Bay dry weather surface water sample did not contain any detectable toxicity (Table 7.7). This sample was evaluated for toxicity using only the sea urchin fertilization test.

7.4.5 Dry Weather Toxicity Identification Evaluations

Sea urchin TIEs were initiated on dry weather samples from the Belmont Pump and Los Cerritos stations. The Belmont TIE was terminated due to a loss of toxicity in the baseline test. Sufficient baseline toxicity was present in the Los Cerritos sample to complete the TIE, however. The toxicity of the Los Cerritos sample was eliminated by addition of EDTA (Figure 7.7). A partial reduction of toxicity was produced by extraction using C-18 and the remaining treatments did not alter the toxicity of the sample. The pattern of response of the sea urchin sperm to the TIE treatments is consistent with the presence of toxic concentrations of divalent trace metals.

Table 7.1. Toxicity of Wet Weather Samples Collected from the City of Long Beach Belmont Pump Station during the 2001/2002 Monitoring Season. Test results indicating toxicity are shown in bold type. The mysid tests were conducted using 100% sample only.

Date	Test	Test Response (% sample)			TUc[d]
		NOEC[a]	LOEC[b]	Median Response[c]	
11/12/2001	**Water Flea Survival**	**<6**	**6**	**3.9**	**>16**
11/12/2001	**Water Flea Reproduction**	**6**	**12**	**8.0**	**16**
11/12/2001	**Mysid Survival**	**≤50**	**≤100**	**na[e]**	**≥2**
11/12/2001	Mysid Growth	nm[f]	nm	na	na
11/12/2001	**Sea Urchin Fertilization**	**3**	**6**	**>50**	**32**
11/24/2001	**Water Flea Survival**	**6**	**12**	**10.2**	**16**
11/24/2001	**Water Flea Reproduction**	**12**	**25**	**15.7**	**8**
11/24/2001	**Mysid Survival**	**≤50**	**≤100**	**na**	**≥2**
11/24/2001	**Mysid Growth**	**≤50**	**≤100**	**na**	**≥2**
11/24/2001	**Sea Urchin Fertilization**	**3**	**6**	**27.1**	**32**

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.
[b] Lowest Observed Effect Concentration: the lowest concentration producing a test response that was significantly different from the control.
[c] Concentration causing 50% mortality to mysids or water fleas (LC50), 50% inhibition in water flea reproduction (IC50) or 50% reduction in sea urchin fertilization (EC50).
[d] Chronic toxicity units = 100/NOEC.
[e] Not applicable.
[f] Not measured due to lack of survivors.

Table 7.2. Toxicity of Wet Weather Samples Collected from the City of Long Beach Bouton Creek Station during the 2001/2002 Monitoring Season. Test results indicating toxicity are shown in bold type. The mysid test was conducted using 100% sample only.

Date	Test	Test Response (% sample)			TUc[d]
		NOEC[a]	LOEC[b]	Median Response[c]	
11/13/2001	**Water Flea Survival**	**25**	**50**	**36.1**	**4**
11/13/2001	**Water Flea Reproduction**	**25**	**50**	**42.2**	**4**
11/13/2001	**Mysid Survival**	**≤50**	**≤100**	**na[e]**	**≥2**
11/13/2001	**Mysid Growth**	**≤50**	**≤100**	**na**	**≥2**
11/13/2001	**Sea Urchin Fertilization**	**3**	**6**	**47.0**	**32**
11/24/2001	**Water Flea Survival**	**50**	**100**	**64.3**	**2**
11/24/2001	**Water Flea Reproduction**	**50**	**100**	**70.1**	**2**
11/24/2001	**Mysid Survival**	**na**	**na**	**na**	**na**
11/24/2001	**Mysid Growth**	**na**	**na**	**na**	**na**
11/24/2001	**Sea Urchin Fertilization**	**3**	**6**	**38.4**	**32**

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.
[b] Lowest Observed Effect Concentration: the lowest concentration producing a test response that was significantly different from the control.
[c] Concentration causing 50% mortality to mysids or water fleas (LC50), 50% inhibition in water flea reproduction (IC50) or 50% reduction in sea urchin fertilization (EC50).
[d] Chronic toxicity units = 100/NOEC.
[e] Not applicable.

Table 7.3. Toxicity of Wet Weather Samples Collected from the City of Long Beach Los Cerritos Channel Station during the 2001/2002 Monitoring Season. Test results indicating toxicity are shown in bold type. The mysid test was conducted using 100% sample only.

		Test Response (% sample)			
Date	**Test**	**NOEC[a]**	**LOEC[b]**	**Median Response[c]**	**TUc[d]**
11/12/2001	**Water Flea Survival**	**12**	**25**	**21.4**	**8**
11/12/2001	**Water Flea Reproduction**	**12**	**25**	**19.9**	**8**
11/12/2001	**Mysid Survival**	**≤50**	**≤100**	**na[e]**	**≥2**
11/12/2001	**Mysid Growth**	**≤50**	**≤100**	**Na**	**≥2**
11/12/2001	**Sea Urchin Fertilization**	**<3**	**3**	**>50**	**>32**
11/24/2001	**Water Flea Survival**	**12**	**50**	**18.8**	**8**
11/24/2001	**Water Flea Reproduction**	**12**	**50**	**19.3**	**8**
11/24/2001	Mysid Survival	na	na	Na	na
11/24/2001	Mysid Growth	na	na	Na	na
11/24/2001	**Sea Urchin Fertilization**	**3**	**6**	**26.5**	**32**

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.
[b] Lowest Observed Effect Concentration: the lowest concentration producing a test response that was significantly different from the control.
[c] Concentration causing 50% mortality to mysids or water fleas (LC50), 50% inhibition in water flea reproduction (IC50) or 50% reduction in sea urchin fertilization (EC50).
[d] Chronic toxicity units = 100/NOEC.
[e] Not applicable.

Table 7.4. Toxicity of Receiving Water Samples Collected from Alamitos Bay during the 2001/2002 Storm Season. Water flea tests were not conducted on these samples.

Date	**Test**	**Estimated % Runoff**	**NOEC[a]**	**TUc[b]**
11/12/2001	Mysid Survival	2	Nontoxic	<1
11/12/2001	Mysid Growth	2	Nontoxic	<1
11/12/2001	Sea Urchin	2	Nontoxic	<1
11/24/2001	Mysid Survival	1	Nontoxic	<1
11/24/2001	Mysid Growth	1	Nontoxic	<1
11/24/2001	Sea Urchin	1	Nontoxic	<1

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.
[b] Chronic toxicity units = 100/NOEC. These values are estimated since the NOEC was not determined through analysis of a dilution series.

Table 7.5. **Summary of TIE Activities.** Acute Toxic Units for the initial (TU-1) and TIE baseline (TU-B) tests are shown (96 hr exposure time for water flea and mysid tests), along with the TIE-related action taken. TIEs were aborted when the baseline TU value was less than 2.0.

		Water Flea			Mysid			Sea Urchin		
Date	**Test**	**TU-I**	**TUB**	**Action**	**TU-I**	**TU-B**	**Action**	**TU-I**	**TU-B**	**Action**
11/12	Belmont	10.7	12	TIE	>1	3.4	TIE	<2	na	none
11/13	Bouton	1.4	1.2	abort	1	na	none	2.1	1.3	abort
11/12	Los Cerritos	2.8	3.3	TIE	<1	na	none	<2	na	none
11/24	Belmont	9.8	3.5	TIE	>1	1.7	TIE	3.7	4.8	TIE
11/24	Bouton	1.6	<1	abort	na	na	none	2.6	6.1	TIE
11/24	Los Cerritos	5.3	3.3	TIE	na	na		3.8	6.2	TIE

Table 7.6. **Toxicity of Dry Weather Samples from the City of Long Beach.** Test results indicating toxicity are shown in bold type.

Station	Date	Test	Test Response (% sample)			TUc[d]
			NOEC[a]	**LOEC[b]**	**Median Response[c]**	
Belmont	5/9/2002	Water Flea Survival	≥100	>100	>100	≤1
Belmont	5/9/2002	Water Flea Reproduction	≥100	>100	>100	≤1
Belmont	**5/9/2002**	**Sea Urchin Fertilization**	**25**	**50**	**47.6**	**4**
Bouton	**5/14/2002**	**Water Flea Survival[e]**	**25**	**50**	**37.5**	**4**
Bouton	**5/14/2002**	**Water Flea Reproduction[e]**	**6**	**12**	**29.6**	**16**
Bouton.	5/14/2002	Sea Urchin Fertilization	≥50	>50	>50	≤2
Los Cerritos	5/9/2002	Water Flea Survival	≥100	>100	>100	≤1
Los Cerritos	5/9/2002	Water Flea Reproduction	≥100	>100	>100	≤1
Los Cerritos	**5/9/2002**	**Sea Urchin Fertilization**	**12**	**25**	**31.8**	**8**

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.
[b] Lowest Observed Effect Concentration: the lowest concentration producing a test response that was significantly different from the control.
[c] Concentration causing 50% mortality to mysids or water fleas (LC50), 50% inhibition in water flea reproduction (IC50), or 50% reduction in sea urchin fertilization or mysid growth (EC50).
[d] Chronic Toxicity Units = 100/NOEC.
[e] The conductivity of this sample was believed to exceed the osmotic tolerance of the water flea.

Table 7.7 Toxicity of the Receiving Water Sample Collected from Alamitos Bay during the 2001/2002 Storm Season.

Date	Test	NOEC[a]	TUc[b]
5/9/2002	Sea Urchin	Nontoxic	$\leq$1

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.

[b] Chronic toxicity units = 100/NOEC. These values are estimated since the NOEC was not determined through analysis of a dilution series.

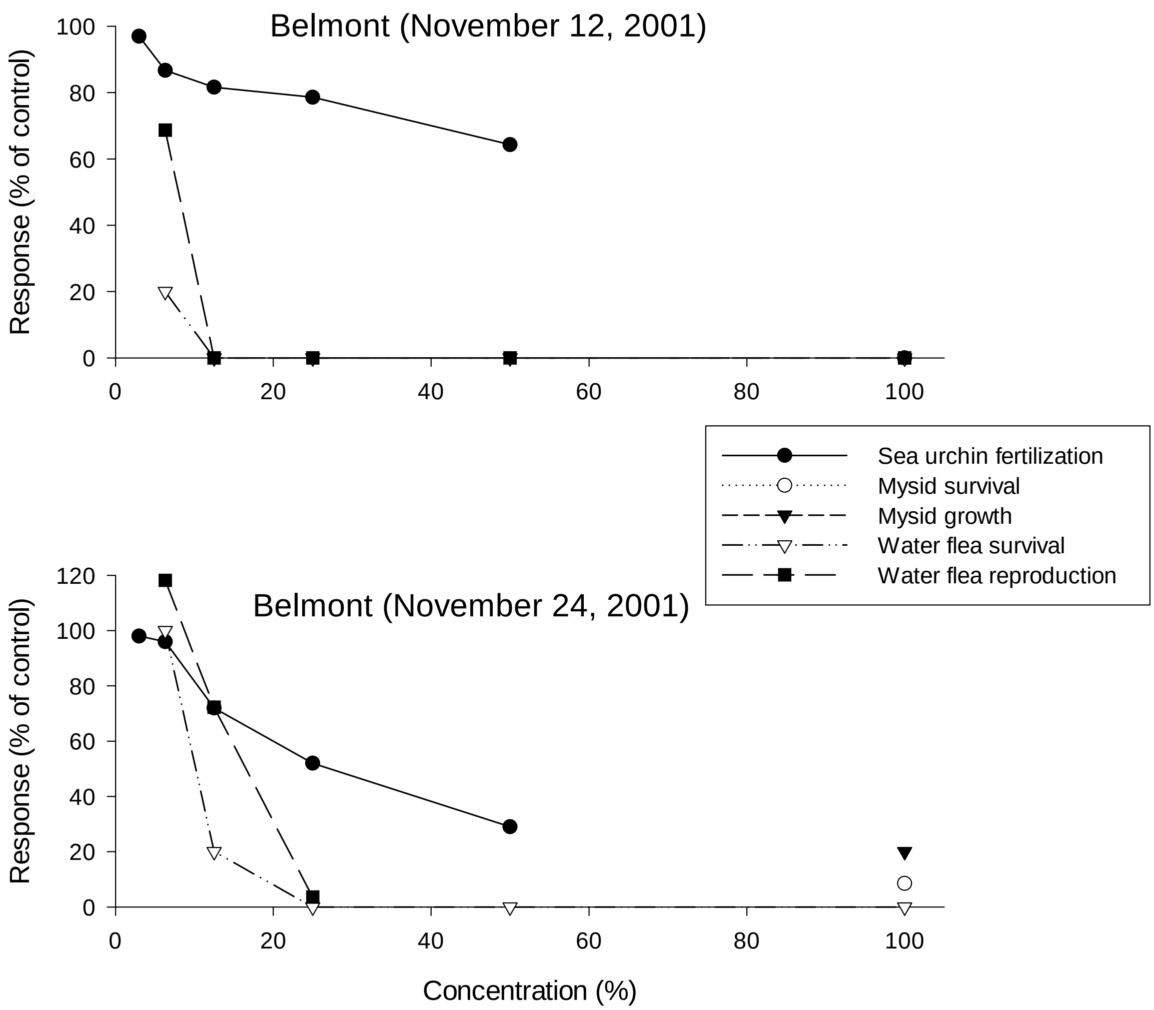


Figure 7.1. **Toxicity Dose Response Plots for Stormwater Samples Collected from the Belmont Pump Station.**

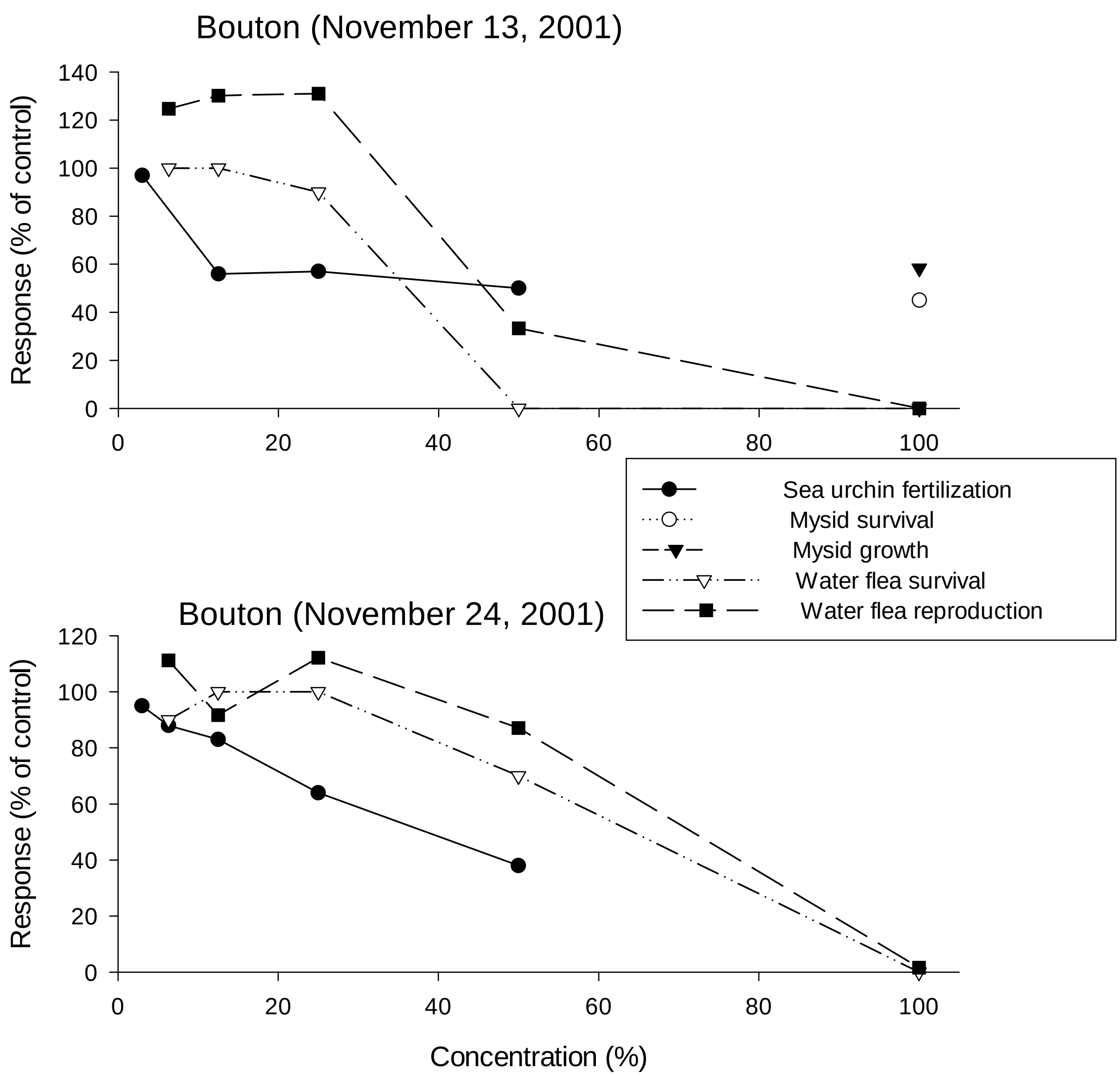
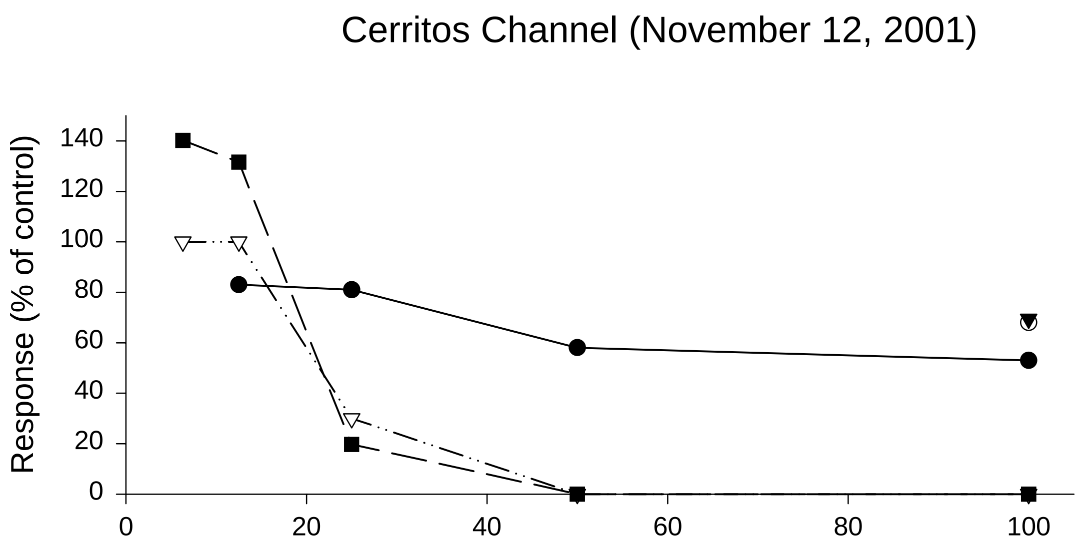


Figure 7.2. Toxicity Dose Response Plots for Stormwater Samples Collected from Bouton Creek.



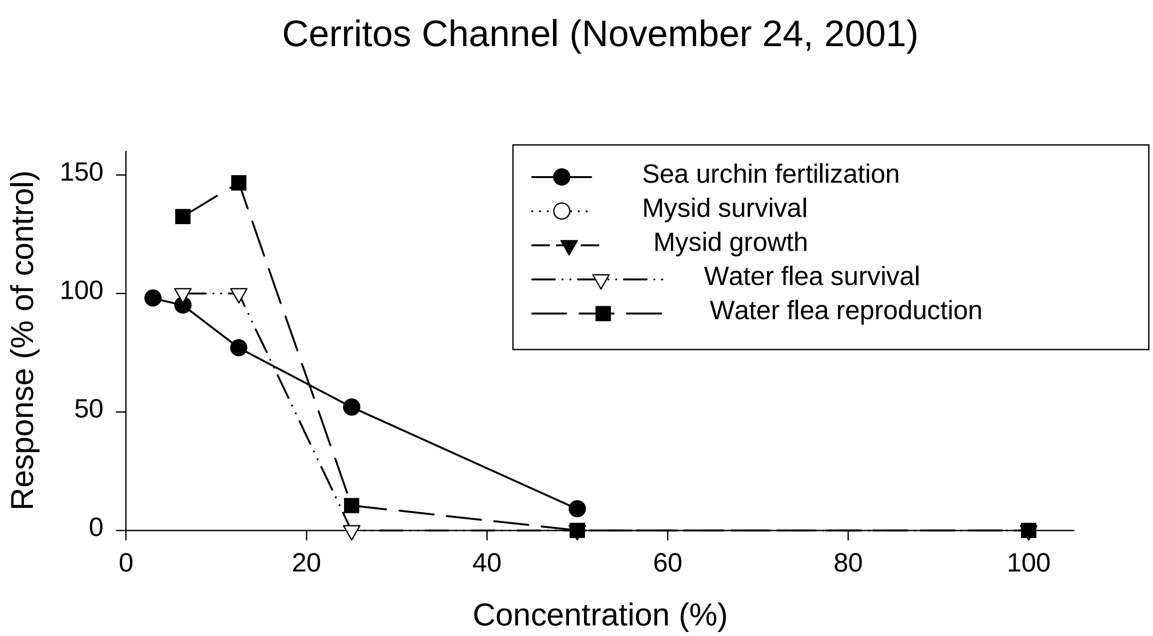


Figure 7.3. Toxicity Dose Response Plots for Stormwater Samples Collected from the Los Cerritos Channel.

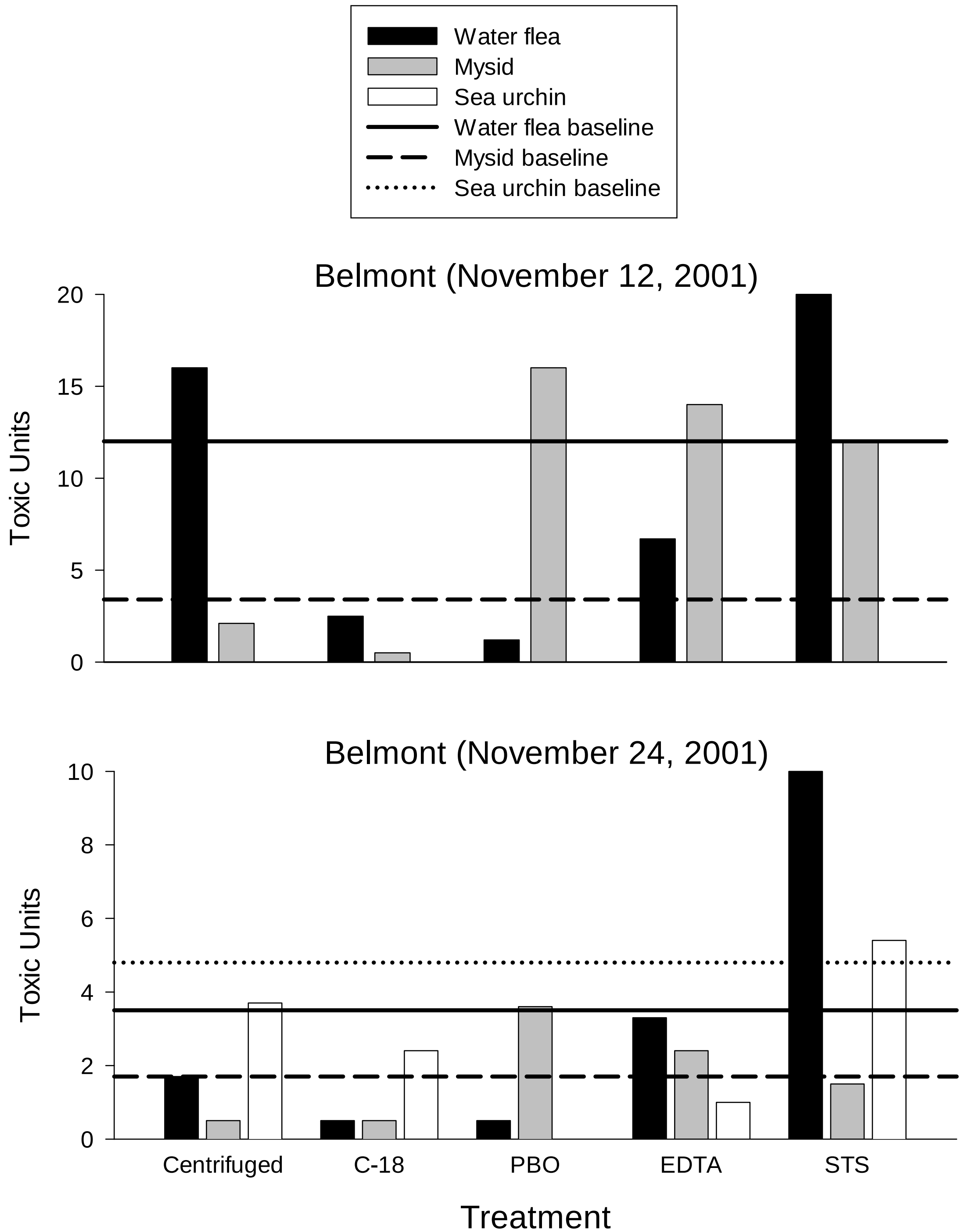


Figure 7.4. Summary of Phase I TIE Analyses on Stormwater Samples from the Belmont Pump Station.

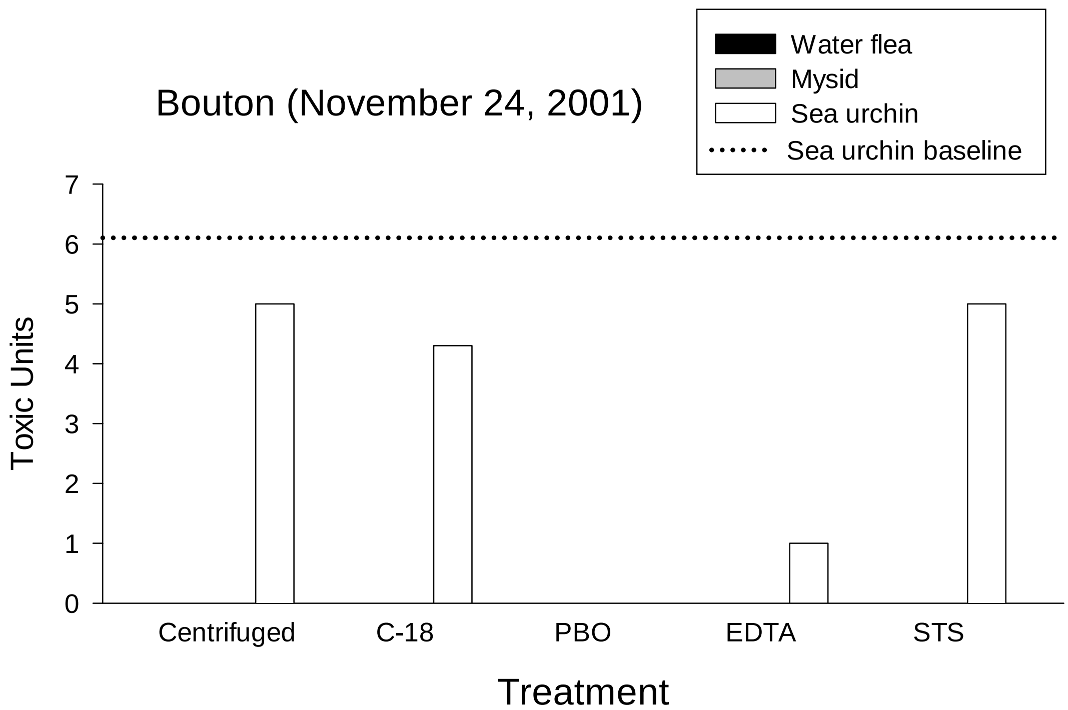


Figure 7.5. Summary of Phase I TIE Analyses on the November 24 Stormwater Sample from the Bouton Creek Station.

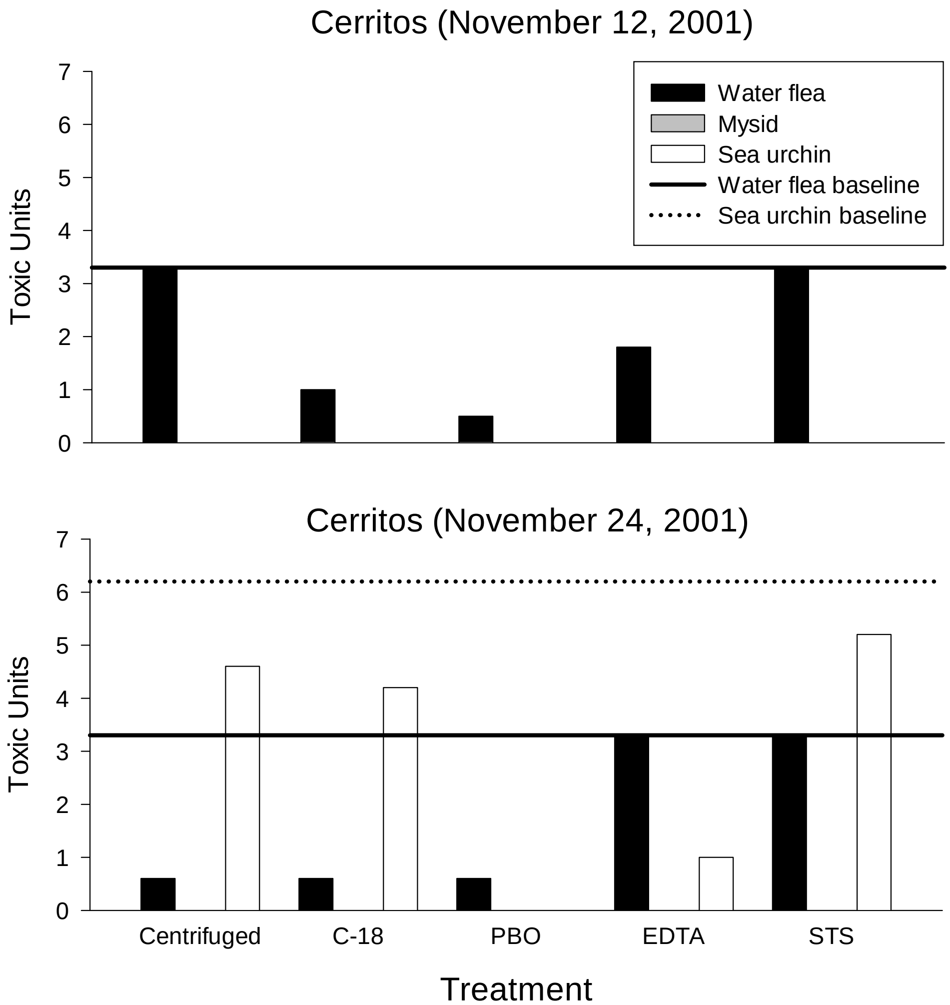


Figure 7.6. Summary of Phase I TIE Analyses on Stormwater Samples from the Los Cerritos Channel Station.

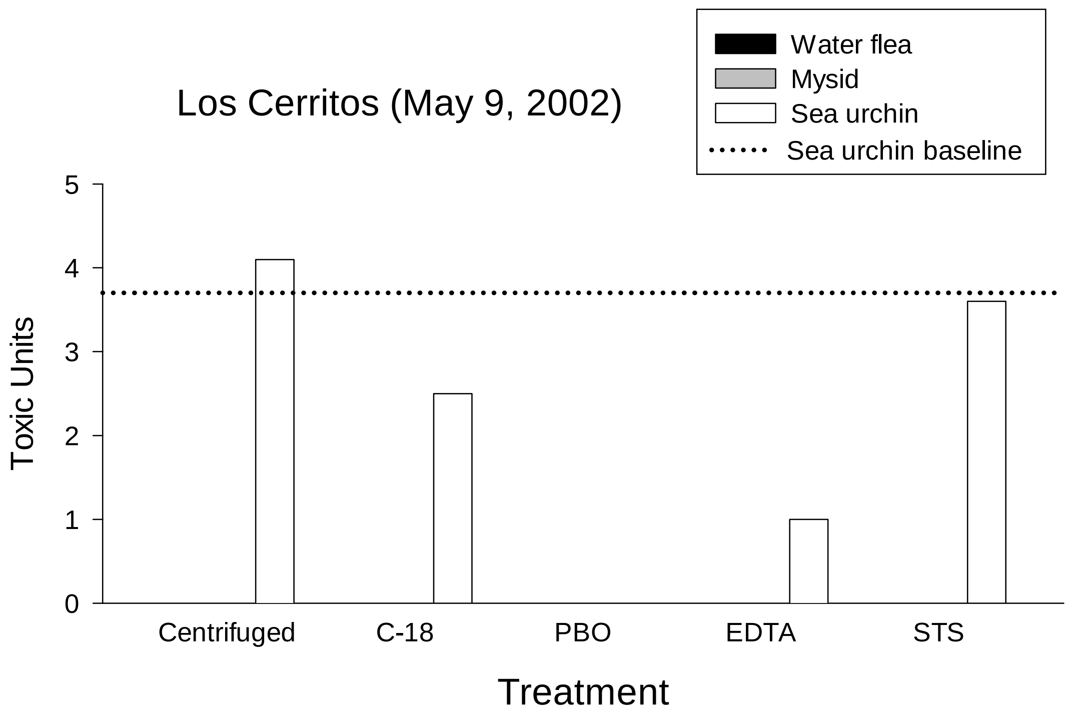


Figure 7.7. Summary of Phase I TIE Analyses on the May 9 Dry Weather Sample from the Los Cerritos Channel Station.

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8.0 DISCUSSION

Water quality criteria or objectives may provide valuable reference points for assessing the relative importance of various stormwater contaminants. Selection of appropriate water quality objectives for comparative purposes is dependant upon designated beneficial uses for each receiving water body. Since the designated beneficial uses for each receiving water body are the driving force in selection of the water quality objectives, beneficial uses were first summarized for each water body (Table 8.1).

Based upon beneficial uses, the receiving water bodies generally fell into two groups. Bouton Creek, Los Cerritos Channel, and the Dominguez Gap Pump Station are all located within Hydrological Unit (HU) 405.15. Principal beneficial uses for receiving water bodies at these locations include potential municipal and domestic water supply (MUN), potential or existing water contact recreation (REC1), intermittent or existing non-contact water recreation (REC2), intermittent or existing warm freshwater habitat (WARM), and existing or potential wildlife habitat (WILD). In addition, receiving water bodies associated with the Dominguez Pump Station are designated as existing ground water recharge (GWR) and potential industrial service supply (IND).

The second group includes water bodies receiving discharge from the Belmont Pump Station and Alamitos Bay. These sites are both within HU 405.12. These receiving water bodies are both marine and estuarine in character. Beneficial uses include commercial and sport fishing (COMM), estuarine habitat (EST), industrial service supply (IND), marine habitat (MAR), rare, threatened or endangered species (RARE), contact (REC1) and non-contact recreation (REC2), shellfish harvesting (SHELL), wetland habitat (WET), and wildlife habitat (WILD).

Currently, numerical standards do not exist for stormwater discharges. Table 8.2 provides a summary of various water quality criteria for each measured constituent, proposed benchmarks for use as reference points to interpret stormwater and dry weather discharges, and the 2001/2002 laboratory method detection limits for each constituent. These benchmarks are intended to serve as a tool for interpreting the stormwater quality data and assuring that beneficial uses are not impacted. Exceedances of these receiving water quality benchmarks do not necessarily indicate impairment. Other factors such as dilution, duration and transformation in the receiving waters must also be considered.

Development of the benchmarks was based upon Marshack (2000) and also upon draft benchmarks under development as part of Project Clean Water in San Diego County (San Diego, Project Clean Water 2001). Averaging intervals for the various water quality objectives were important considerations in selection of benchmarks. Appropriate water quality goals for use as benchmarks for discharges from Bouton Creek, Los Cerritos Channel and the Dominguez Gap Pump Station are listed as Inland Surface Water Discharges. Proposed water quality goals for the Belmont Pump Station and Alamitos Bay sites are listed as Enclosed Bay and Estuary Discharges. In using these benchmarks, it is important that the source of the specific criterion is considered. For instance, metals concentrations derived from California Toxics Rule (CTR) freshwater criteria for protection of aquatic life are based upon dissolved concentrations and are often a function of hardness. Values listed are based upon a default hardness of 100 mg/L. In addition, saltwater objectives listed for metals under the CTR are based upon dissolved concentrations while those listed under the California Ocean Plan are based upon total recoverable measurements. The source of each particular benchmark is identified in columns to the right of the proposed benchmark/water quality goals or, in some cases, in footnotes.

8.1 Wet Season Water Quality

Stormwater quality data from the four mass emission sites in Long Beach were grouped to provide an initial characterization of discharges from the City (Table 8.3). Descriptive statistics were based upon detected values and the assumption that all data are log normally distributed. Most stormwater investigations conducted since the initial Nationwide Urban Runoff Program (NURP) (EPA 1983b) studies have found that the majority of constituents in stormwater tend to be log normally distributed. As the City of Long Beach database expands, the distribution of these data will be tested to determine if transformations are necessary for statistical comparisons and methods will be applied to incorporate censored (below detection limit) data where appropriate.

The mean EMCs from the combined data from all Long Beach mass emission sites are developed and presented in Table 3. A simple, tabulated comparison of these mean EMCs is not possible because of the multiple benchmark sources, and intended purposes of these benchmarks. Rather comparisons are made in the text that follows.

Among the conventional pollutants, oil and grease, total suspended solids (TSS), and bacteria were the only constituents that exceeded the proposed stormwater benchmark values. Water samples to be analyzed for oil and grease are taken as grab samples and therefore only provide an instantaneous measurement of the discharges. In addition, oil and grease are typically not well mixed in the stormwater samples. An exception may be samples taken at the Belmont Pump Station during events sampled this year. Grab samples were taken at the discharge point in extremely turbulent water. The proposed benchmark for oil and grease was 15 mg/L based upon the median Stormwater Effluent Limitation Guidelines in USEPA's Stormwater Multi-Sector General Permit for Industrial Activities. Oil and grease was detected above the reporting limit of 5 mg/L in about one third of the samples taken at both the Belmont Pump Station and in the Los Cerritos Channel. When detected, the mean concentration of oil and grease at these two sites was 2 to 2.5 times the benchmark values. Benchmark values for TSS were based upon the 2001 Ocean Plan Instantaneous Maximum of 60 mg/L is applied to enclosed bays and estuaries, and the median EMC of 100 mg/L for TSS from the National Urban Runoff Program (NURP) for inland surface waters. The mean TSS EMC for the Belmont Pump Station Discharge is 602 mg/L or roughly 10 times the proposed benchmark. The mean TSS EMCs for Bouton Creek and the Los Cerritos Channel ranged from 476 to 516 mg/L or roughly five times the benchmark for inland waters. The impacts of excursions above these candidate benchmarks and the appropriateness of the benchmarks are difficult to assess. The proposed benchmark for TSS discharges to inland waters is inherently conservative since we are comparing log-normal means to medians. Use of the NURP median value was simply based upon maintenance of consistency with draft reference values currently being considered for San Diego County.

Concentrations of bacteria in stormwater runoff routinely exceed proposed benchmark levels. Mean EMCs for fecal coliform are highest at the Belmont Pump Station where the stormwater is discharged directly to Alamitos Bay. Mean values are three orders of magnitude greater than the benchmark values that were based upon receiving water limits. Elevation of bacteria in stormwater discharges may not be completely controllable. A number of studies have indicated that high levels of bacteria are present in discharges from areas that are relatively unimpacted by urban activities. Work conducted in San Diego (Kinnetic Laboratories, Inc. 1995a) and in Santa Cruz (Kinnetic Laboratories, Inc. 1995b) demonstrated comparable bacterial concentrations in runoff from both chaparral and highly urbanized catchments.

Benchmark values used for trace metals are mostly based upon Criteria Maximum Concentrations (CMC) from the California Toxics Rule (USEPA 2000). These values are for the dissolved fraction and are often a function of hardness. When criteria were a function of hardness, a default value of 100 mg/L was used for tabulated benchmark values in Table 8.2. The CMC was selected as the appropriate benchmark value since stormwater impacts are generally of short duration. Use of the CMC is also consistent with the San Diego Project Clean Water draft benchmarks. Derivation of beryllium and total chromium benchmark values differed from the other metals. The benchmark value for beryllium in bays and estuaries is based upon the 2001 Ocean Plan. The value of 0.033 µg/L is based upon 30-day average exposures to organisms when consumption may result in cancer risk to humans. This is evaluated analytically by meeting the established minimum level (ML) of 0.5 µg/L. All beryllium measurements were below the laboratory ML of 0.5 µg/L. Total chromium benchmarks are derived from the instantaneous maximum (20 µg/L) from the 2001 Ocean Plan inland and drinking water standards. Both are based upon total recoverable measurements. Mean EMCs for total chromium at each site were below the benchmark at all sites.

Only two metals were found to exceed benchmark values. Mean site EMCs for copper and zinc exceeded benchmark values at some sites. In both cases, only the estuarine/marine benchmarks were exceeded. The mean EMC for copper at the Belmont Pump Station was approximately three times the benchmark value for discharges to enclosed bays and estuaries. Mean copper EMCs for discharges to inland surface waters were below the benchmark value of 13 µg/L. The mean EMC for dissolved zinc at the Belmont Pump Station was 98 µg/L, slightly exceeding the enclosed bay and estuary benchmark value of 90 µg/L. Mean EMCs for dissolved zinc at both Bouton Creek and Los Cerritos were 78-84 µg/L, which was approximately 2/3 of the inland surface water benchmark.

Organic compounds were rarely detected in the stormwater samples. When detected, these compounds were often very near reporting limits. Exceptions included occasional occurrences of bis(2-ethylhexyl) phthalate at levels of up to 35 µg/L during the first monitoring season and up to 10 µg/L this past season. Diazinon was detected at concentrations as high as 3.0 µg/L this season. Diazinon benchmarks are routinely exceeded in discharges from the Belmont Pump, Bouton Creek, and the Los Cerritos Channel. Benchmark values for both saltwater and freshwater were based upon recent assessments conducted by the California Department of Fish and Game (Seipmann and Finlayson 2002). Mean EMCs for the two monitoring sites that discharge to inland surface waters were roughly four to five times higher than the proposed benchmark. Discharge from the Belmont Pump station had a site mean EMC that was an order of magnitude greater than the benchmark. Chlorpyrifos, another organophosphate pesticide, was found in significant concentrations in water from the second storm event in the Los Cerritos Channel. Measured concentrations of chlorpyrifos in this sample were approximately one order of magnitude greater than the recently updated California Department of Fish and Game CMC (Seipmann and Finlayson 2002).

Most other organic compounds are rarely detected or are typically near minimum levels (MLs). Glyphosate, which was detected in runoff the previous year was not detected in runoff from any of the sites during the 2001/2002 season. Low levels of two organochlorine pesticides, DDT and aldrin, were present in a few samples during the 2001/2002 monitoring year.

Both diazinon and chlorpyrifos are undergoing changes in registration due to the high toxicity of diazinon and chlorpyrifos as well as persistent occurances in runoff. EPA and the registrants have agreed to phase out use of diazinon for outdoor residential lawn and garden uses (EPA 2001). The agreement virtually ends sales of diazinon for residential lawn care by 2003. Residential uses of chlorpyrifos (EPA 2000) are also being phased out. Thus, threats to aquatic life posed by these two compounds should be expected to decline over the next ten years. It is expected that household stockpiles of these pesticides will continue to used for several years after these chemicals are no longer available for residential use. It is possible, however, that educational/informational programs may help to reduce these stockpiles and prevent further use.

8.2 Dry Season Water Quality

8.2.1 Chemical Analysis of Dry Weather Samples from Mass Emission Sites

As in the previous year, chemical results generally did not tend to vary greatly between sites or sampling dates (Table 6.6). With a few exceptions, contaminant concentrations were consistent with previous results and no parameters stood out as particularly high. Several phthalate compounds were detected in samples from the August 2001 survey but were below detection limits in the May 2002 surveys. The herbicide, 2,4-D, was absent from all sites in the fall survey but was present in all samples from the May survey. Diazinon was the only organic contaminant routinely detected in the dry weather discharges. This was not true in previous years due to higher detection limits.

Dry weather discharges were typically low in suspended solids and total metals. The relationships between dissolved and total metals were more consistent with expected dissolved/total ratios than those measured during wet weather events. With a few exceptions, dissolved metals occur at levels similar to those measured during the winter storm events (Tables 6.2 and 6.6). The primary difference between the wet and dry weather concentrations of dissolved trace metals is the increased hardness which tends to mitigate potential toxicity.

Elevated pH levels have been common during dry weather sampling efforts (Kinnetic Laboratories, Inc. /SCCWRP 2001). These mostly occur in open channel sites such as Bouton Creek and the Los Cerritos Channel. It is not unusual to see pH levels in excess of 9.0. This past year, a pH of 9.66 was measured in samples taken from Los Cerritos Channel. Occurrences of elevated pH in these channels is likely due to high benthic algal production resulting in low levels of CO_2. Concurrent high levels of dissolved oxygen would tend to further support algal production as the cause of the elevated pH. In addition, alkalinity also tends to be lowest at sites where high pH values were encountered.

Despite efforts to isolate dry weather flows in Bouton Creek, the very low flows and large surface area of the channel tend to result in higher specific conductivities, COD, chloride and TDS. Saltwater continues to drain from the algal turf well after the water level is below the sampling point. In addition dry weather flows are not substantial enough to drive the saltwater out of the channel. Despite these problems, movement of the sampling point to a location further up the channel would result in the loss of potential flow from numerous drains that enter along the channel.

Dry weather flows continue to show moderately high levels of bacteria including total and fecal coliform as well as enterococci (Table 6.6). All total and fecal coliform measurements were above benchmark levels except for one field duplicate for fecal coliform at Bouton Creek. The effects of these discharges, however, are not typically evident in receiving waters as demonstrated both by concurrent measurements from Alamitos Bay and surveys conducted by the City's Department of Health discussed in the following section.

8.2.2 Bacteriological Data from Alamitos Bay

Microbiological contamination in Alamitos Bay has been a major concern during summer months when bathers are utilizing local beaches. Due to these concerns, a low flow diversion for Drainage Basin 24 to prevent dry weather flows from entering the Bay from this Drainage Basin. The low-flow diversion was activated on May 1, 2000. Prior to activation of the diversion, dry weather flows were discharged at the Bayshore Aquatic Park on the southwestern shoreline of Alamitos Bay. This stormwater monitoring program has now sampled total coliform, fecal coliform, fecal streptococcus/enterococcus in Alamitos Bay near the discharge point for Basin 24 once prior to activation of the dry weather intercept and five times during dry weather periods subsequent to activation of the low-flow intercept. Due to the limited temporal and spatial extent microbiological information associated with this program, alternative data sources were investigated to assist in evaluation of the effectiveness of the diversion. Data from the ongoing microbiological monitoring being conducted by the City of Long Beach Department of Health and Human Services was obtained during the previous year. This data set was updated with additional data from June 2001 through June 2002 provide additional post-implementation data.

The City of Long Beach Department of Health and Human Services (Ms. Mae Nikaido) provided updates of microbiological data from monitoring conducted in and near Alamitos Bay since 1997. Historical data exist for total coliform, fecal coliform (or *Escherichia coli)* and enterococcus at five locations. In January 2000, the Department of Health and Human Services switched from using fecal coliform to use of *E. coli* as a surrogate from fecal coliform. In June 2001, the Department abandoned use of *E. coli* and returned to use of fecal coliform. The length of data records varies among the sites but the most complete survey records start in March 1999. The monitoring sites are shown in Figure 8.1 and are listed below starting from sites within Los Cerritos Creek and proceeding towards the entrance of the Bay:

- B27 - Los Cerritos Creek by Golden Sail (Near mouth of Los Cerritos Cr.)
- B28 - Long Beach Rowing Association (Near Los Cerritos Cr. and Marine Station)
- B67 - Bayshore and Second St. Bridge (Near outlet of Belmont site)
- B29 - First and Bayshore (Nearest our Station -end of East First Street and Bayshore Ave.)
- B14 - Bayshore Float (Out close to Mouth, North of spit of E. Bayshore Walk)

The B29 monitoring site is located at the Bayshore Aquatic Park a short distance from the Alamitos Bay receiving water site monitored as part of the City's stormwater program.

Department of Health and Human Services monitoring data were compared with historical rainfall records from the Long Beach Airport. Microbiological data from extended dry weather conditions occurring between late spring and early fall of each year were extracted from the data set and available data are identified in Table 8.4. This summary identifies the dry weather period for each year, the total number of measurements taken during each dry weather period and the percentage of measurements exceeding Ocean Plan and AB411 reference values. The frequency of exceedances of the Ocean Plan reference value refers to single measurements that exceed the standard for 30-day averages. It was used only as a benchmark. None of the data indicated presence of sustained levels that would violate Ocean Plan Standards. For visual inspection of these data, time-series plots are provided for each site for total coliform, fecal coliform and enterococcus (Figures 8.2 through 8.6).

General trends remained similar to those observed in previous years (Kinnetic Laboratories, Inc./SCCWRP, 2001). Concentrations of bacteria are consistently lower at the lower Alamitos Bay sites B27 and B28 in comparison to other sites. Concentrations of fecal coliform most frequently exceed reference levels at the B67 and B29 monitoring sites. Enterococcus bacteria were only tested at the three sites closest to the ocean during the 1999, 2000, and 2001 dry weather seasons. During the 1999 dry weather season, reference levels were most commonly exceeded at the B67 monitoring site. During both the 2000 and 2001 dry weather seasons, excursions above reference levels were most common near the mouth of Alamitos Bay at the B14 monitoring site. Overall, the frequency of dry weather exceedance of the enterococcus standards was lower in 2001 compared to dry weather monitoring conducted in 2000. Fewer single measurements exceeded the 30-day average Ocean Plan limit of 35 mpn/100 ml and none exceeded the AB411 Instantaneous Limits.

Microbiological data from the City's stormwater program demonstrate relatively low levels of total coliform, fecal coliform, and enterococcus during all dry weather periods including the preimplementation survey and each of the five post-implementation dry weather surveys. Tests conducted during wet weather periods resulted in levels of each bacterial component that were one to two orders of magnitude higher that during summer dry weather periods.

As noted in the previous year, monitoring data continue to show no apparent changes in the bacterial concentrations in Alamitos Bay during the summer that can be related to activation of the dry weather interceptor in Basin 24 in May 2000.

8.3 Temporal Trends of Selected Metals and Organic Compounds

Temporal trends were examined for selected trace metals and organic compounds that are often high in storm drain discharges or suspected to be primary sources of toxicity (Figures 8.7 through 8.18). Trace metals include cadmium, copper, nickel, lead, and zinc. Temporal trends of two organophosphate pesticides, chlorpyrifos and diazinon, were also examined. Figures 8.7 through 8.18 include both wet weather and dry weather monitoring data from each of the four sites. Dry weather sampling periods are delineated by the shaded areas. Due to the typically large differences between total lead and dissolved lead concentrations, especially during storm events, a separate graphic is included to examine temporal trends for dissolved lead.

During the 2000/2001 monitoring season, sampling was started well into the storm season. Sampling conducted this year produced the first results from a first flush event. The relatively small first flush event yielded the highest concentrations of total cadmium, copper, nickel, lead and zinc encountered in the first two years of stormwater monitoring. Despite the increases in total metals, concentrations of dissolved metals remained comparable to those reported during other storm events. During dry weather periods, most total metal concentrations tend to be both lower and more comparable to dissolved metal concentrations. Nickel is an exception. Based upon the current database, nickel concentrations during dry weather events have tended to be highly variable. During the summer 2001 dry weather surveys, both dissolved and total nickel concentrations were often as high or higher than concentrations measured during storm events. The occurrence of elevated levels of nickel in dry weather flows appears to have been limited to the summer of 2001, but it is premature to conclude that this was an isolated occurrence.

Temporal trends for diazinon and chlorpyrifos are obscured by higher detection limits utilized during the first year of the program. Diazinon occurs in both wet weather and dry weather flows at relatively high levels. Highest concentrations have been found in discharges from the Belmont Pump station but discharge volumes have typically been low at this site. Chlorpyrifos was not detected during the first year but it is likely that this was due to high reporting limits. Thus far, detectable quantities of chlorpyrifos have been limited to stormwater discharges. As noted earlier, both these pesticides are currently being phased out for common residential uses. This process is expected to result in significant reductions of the mass discharge of these two pesticides in association with both wet and dry season flows.

8.4 Stormwater Toxicity

A total of six wet weather samples were analyzed for toxicity during the monitoring period. Each sample produced similar results in that toxicity was observed in all of the test species. The sea urchin test was the most sensitive toxicity test method. The toxicity of the two wet weather samples analyzed during the monitoring period was substantially greater than that measured during the previous monitoring period (Figure 8.19). The two samples from each of the three locations contained greater toxicity to sea urchins than any Long Beach sample tested previously.

The samples of dry weather discharge collected in May 2002 were toxic, but the magnitude of toxicity was less than most of the stormwater samples analyzed during 2001 (Figure 8.19). These data are consistent with the results of dry weather samples analyzed during the 2000/2001 monitoring period and indicate that there are significant differences in the composition of stormwater and dry weather discharge from the City of Long Beach.

8.4.1 Receiving Water Toxicity

No significant toxicity was present in the two Alamitos Bay receiving water samples collected and tested during wet weather. These results are consistent with the results of wet weather and dry weather bay samples analyzed during the previous monitoring period. Salinity measurements indicated that the wet weather receiving water samples contained less than 5% freshwater. The lack of toxicity in the Alamitos Bay samples is consistent with the results of the wet weather discharge samples, which usually had LOEC values of greater than 5%.

The results of the receiving water sample analyses should not be used to describe water quality throughout Alamitos Bay. Test samples were collected from only one location in the bay and the results may therefore not be representative of other locations in Alamitos Bay, especially those areas located near major stormwater discharges.

8.4.2 Temporal Toxicity Patterns

The small number of storms sampled during the monitoring period (2), and the brief separation in time between them (<2 weeks) does not allow for the evaluation of temporal trends among the data. All samples from these two storms were more toxic than any sample collected during the 2000/2001 monitoring period, however. The samples collected in November 2001 represented the first significant storms of the season, whereas the samples from February-April 2001 were collected after approximately 30% of the season's rainfall had already occurred.

The toxicity data from the 2000/2001 and 2001/2002 monitoring periods suggest that seasonal flushing may be an important factor affecting the variability in stormwater toxicity. In previous studies, it was found that early season storm water runoff from Ballona Creek (Los Angeles County) was more toxic than samples obtained later in the season (Bay *et al.* 1999).

8.4.3 Comparative Sensitivity of Test Species

For five of six samples, the sea urchin fertilization test was the most sensitive toxicity test method. The water flea survival/reproduction test was the most sensitive method for the November 24 sample from Bouton Creek. The relative sensitivity of the mysid toxicity test could not be evaluated for this monitoring period because only the 100% stormwater concentration was tested, which prevented estimation of a precise value for the EC50 or NOEC. Mysid survival and growth in 100% stormwater generally indicated less toxicity than the sea urchin or water flea results for similar sample concentrations, indicating that the mysid test was the least sensitive of the three methods. This same pattern of sensitivity (sea urchin > water flea > mysid) was also observed during the 2000/2001 monitoring program and in a study of urban stormwater toxicity in San Diego (Southern California Coastal Water Research Project 1999).

8.4.4 Relative Toxicity of Stormwater

The frequency and magnitude of stormwater toxicity from the Long Beach stations is similar to stormwater samples from other southern California watersheds (Table 8.5). Results from the Chollas Creek and Ballona Creek studies are probably most similar to the Long Beach study, as these samples were obtained from smaller highly urbanized watersheds, relative to the samples from the L.A. River and San Gabriel River. As with the Long Beach samples, toxicity in other watersheds is variable among storms, and stormwater toxicity is usually detected using the sea urchin fertilization test.

8.4.5 Toxicity Characterization

The TIE testing program for this monitoring period was quite successful. Phase I TIEs were attempted on 12 wet weather and 2 dry weather samples and they yielded useful information for 10 samples. The remaining TIEs were not useful due to the loss of toxicity with time in the laboratory.

The results of the 2001/2002 TIE analyses were consistent within each species and similar to the data obtained from the previous year (Table 8.6). All of the TIEs conducted using the water flea indicated that organophosphate pesticides was the most likely category of toxic constituents. This conclusion is supported by the effectiveness of the C-18 and PBO treatments for reducing toxicity to the water flea. Other monitoring programs in California have obtained similar Phase I TIE results and subsequent studies have verified that OP pesticides are frequently the cause of urban stormwater toxicity to this species.

The sea urchin TIE results consistently identified EDTA as the most effective treatment for removing toxicity. EDTA is effective at chelating divalent metals, such as copper, cadmium and zinc, thus rendering them biologically unavailable. Studies in other watersheds have also found EDTA to be successful at removing toxicity from runoff (Jirik *et al.* 1998, Schiff *et al.* 2001). In these studies, copper and zinc were found to be the specific metals most likely causing toxicity. Solid phase extraction using C-18 was partially effective at removing toxicity to sea urchins from most of the Long Beach samples tested. This treatment is intended to remove non-polar organic contaminants from the sample. However, C-18 treatment has also been shown to remove significant amounts of toxicity associated with copper and zinc from the sample (Schiff *et al.* 2001). Since both solid phase extraction and EDTA were highly effective in these samples, it is likely that divalent metals, rather than organics, caused the observed toxicity. The other possibility is that both metals and non-polar organics are present and acting in a synergistic manner so that the removal of one effectively eliminates most of the toxicity in the sample. Additional tests are necessary to confirm the unlikely presence of such a synergistic effect.

The removal of particles by centrifugation was effective in partially reducing toxicity in only one sample. Previous studies have also found particle removal to be an ineffective method for the removal of toxicity from stormwater (Bay *et al.* 1999). However, particles may contribute to the chemical-associated toxicity of stormwater from the desorption of bound contaminants into the water. A previous study found that urban stormwater particles released toxic quantities of unidentified materials into clean seawater in less than 24 hours (Noblet *et al.* 2001).

Correlation analysis of the toxicity and chemistry data provides an additional test of the association between stormwater toxicity and chemical contamination. Insufficient data were available to conduct correlation analyses using just the data from the 2001/2002 monitoring period. Instead, the data from both years of monitoring were pooled for the correlation analyses, except for tests using diazinon and chlorpyrifos, which were not detected in the first year of monitoring. The correlation analyses confirm the results from the first year of study: that the toxic responses measured in this study are related to the chemical composition of the stormwater samples. The toxic responses of sea urchins or water fleas were significantly correlated with increased concentrations of several stormwater constituents, including dissolved metals, TSS and TOC (Table 8.7). Dissolved zinc was the only constituent that was significantly correlated with toxicity to both species, this metal also showed the strongest correlation with reduced sea urchin fertilization. Increased copper was the only other constituent that was significantly correlated with sea urchin fertilization; these results differed from those obtained using only the first year's monitoring data, which obtained significant correlations with dissolved cadmium and chromium.

A larger number of constituents were significantly correlated with toxicity to the water flea, including TSS, TOC, and dissolved metals including Cd, Cr, Pb, Ni, and Zn (Table 8.7). Increased concentrations of the OP pesticides chlorpyrifos and diazinon had moderate correlations with water flea toxicity ($r=0.54$), but the association was not statistically significant due to the small number of data points available.

The presence of significant correlations between toxicity and selected chemicals supports the TIE results and provides information to help identify key constituents of concern, but the statistical results do not prove that those constituents are the cause of toxicity. The true cause of toxicity may be another (possibly unmeasured) constituent that has a similar pattern of occurrence in the samples. A third method, comparing the measured and predicted toxic units of the samples was used to assess the importance of zinc, copper, and pesticides as a cause of the toxicity of Long Beach stormwater. The predicted toxicity of the sample was calculated from the measured concentrations of the chemical constituents and the corresponding EC50 or LC50. This toxic unit comparison showed that five of six stormwater samples contained sufficient dissolved zinc and copper to account for nearly all of the toxicity measured (Figure 8.20). These results were similar to those obtained for the first year's monitoring data.

Comparison of the measured and predicted toxic units for the water flea tests (Figure 8.21) showed a different pattern from that obtained for the sea urchin tests. The toxicity of two of the five samples containing substantial toxicity could be accounted for by the measured concentrations of diazinon and chlorpyrifos. Zinc was estimated to contribute ≤ 1 toxic unit and copper contributed even less toxicity to the samples (data not shown). The measured concentrations of op pesticides, zinc and copper accounted for less than 50% of the toxicity of both November 2001 Belmont Pump samples and one Los Cerritos Channel sample, suggesting that additional unmeasured toxicants are present. Alternatively, the undetected poor recovery of chemical analytes or losses during storage may have reduced the measured concentrations of some constituents and resulted in low predicted toxicity values.

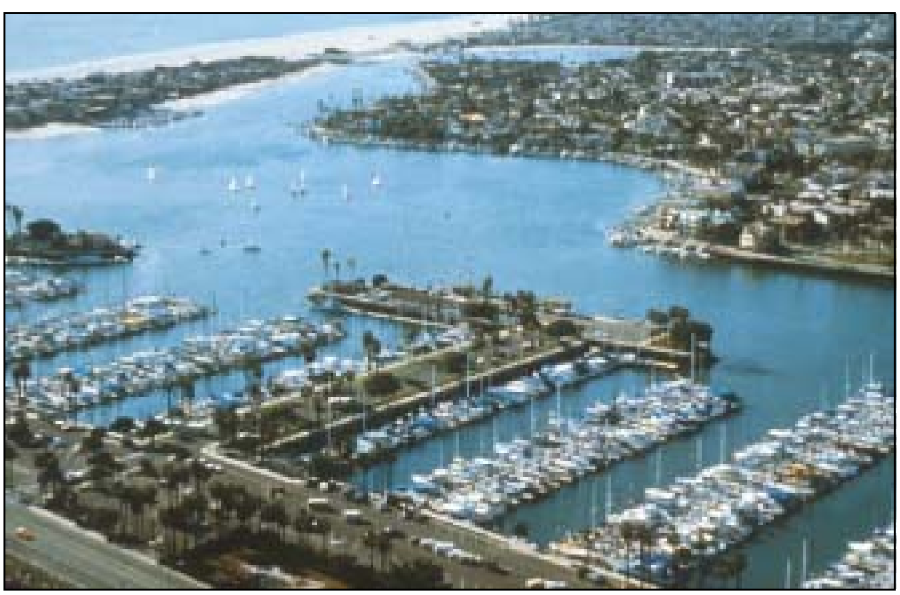


Table 8.1. Summary of Beneficial Uses for Receiving Water Bodies Associated with each Monitoring Location[1]

DISCHARGE LOCATION	HYDRO. UNIT	COMM	EST	GWR	IND	MAR	MUN	NAV	RARE	REC1	REC2	SHELL	WARM	WET	WILD
Bouton Creek	**405.15**						**P**			**P**	**I**		**I**		**E**
Los Cerritos Channel	**405.15**						**P**			**P**	**I**		**I**		**E**
Dominguez Gap Pump Sta.	**405. 15**			**E**	**P**		**P**			**E**	**E**		**E**		**P**
Belmont Pump Sta.	**405.12**	**E**	**E**		**E**	**E**		**E**	**E**	**E**	**E**	**E**		**E**	**E**
Alamitos Bay	**405.12**	**E**	**E**		**E**	**E**		**E**	**E**	**E**	**E**	**E**		**E**	**E**

1. Source: California Regional Water Quality Control Board, Los Angeles Region. 1994. Water Quality Control Plan, Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties. P=Potential, E=Existing, and I=Intermittent

Commercial and Sport Fishing (COMM): Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Estuarine Habitat (EST): Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Ground Water Recharge (GWR): Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Industrial Service Supply (IND): Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

Marine Habitat (MAR): Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation, such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Municipal and Domestic Supply (MUN): Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water.

Navigation (NAV): Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Rare, Threatened, or Endangered Species (RARE): Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Water Contact Recreation (REC-1): Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2): Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sun bathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Shellfish Harvesting (SHELL): Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

Warm Freshwater Habitat (WARM): Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Wetland Habitat (WET): Uses if water that support wetland ecosystems including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

Wildlife Habitat (WILD): Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., Mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Table 8.2. Summary of Applicable Water Quality Benchmarks and Receiving Water Quality Criteria (Page 1 of 5)

Analytes	Units	Benchmarks		Water Quality Criteria										Lab. ML
				California Toxics Rule		California Ocean Plan (2)		USEPA Ambient Criteria		USEPA IRIS Reference Dose as a Drinking Water Level (4)	California Drinking Water Standard (5)	USEPA Drinking Water Standard (6)	Basin Plan (7)	
		Enclosed Bay & Estuary Discharge (Saltwater)	Inland Surface Water Discharge (Freshwater)	Saltwater (1A)	Freshwater (1B)	Saltwater Aquatic Life Protection	Consumption of Aquatic Organisms Only	Saltwater Aquatic Life Protection (3A)	Freshwater Aquatic Life Protection (3A)					
BOD5	mg/L	30(4)	30(4)											2
COD	mg/L	120(9)	120(9)											20-900
Total Organic Carbon	mg/L													1
Specific Conductance	umho/cm		900											1
Total Hardness	mg/L													2
Alkalinity	mg/L													2
PH	units	6.0-9.0	6.0-9.0				6.0-9.0	6.0-8.5	6.0-9.0					0-14
Cyanide	mg/L	0.001(1H)	0.022(1H)	0.001(1H)	0.022(1H)	0.004(DM)		1	22	0.14	0.2	0.2	0.2	0.005
Chloride	mg/L		150						860(1)				150	2
Fluoride	mg/L		0.42							4.2	2	4	1.4	0.1
Total Kjeldahl Nitrogen	mg/L													0.1
Total Ammonia – Nitrogen	mg/L	6(IM)	12.1			6(IM)		0.233(1H)	12.1					0.1
Nitrite	mg/L	0.7	0.7							0.7	1	1	1	0.1
Nitrate	mg/L		10							11	10	10	10	0.1
Total Phosphorus	mg/L		0.5							0.00014	0.5	0.5		0.05
Dissolved Phosphorus	mg/L									0.00014				0.05
MBAS	mg/L	0.5	0.5								0.5			0.5
MTBE	mg/L	0.013	0.013								0.013			0.001
Total Phenols	µg/L	4,600,000	4,600,000	4,600,000	4,600,000	120(DM)			2560	4200				0.1
Oil & Grease	mg/L	15 (12)	15(12)				75(IM)							5
TPH	mg/L	0.02	0.02											5
Total Suspended Solids	mg/L	60(IM)	100(13)			60(IM)								2
Total Dissolved Solids	mg/L													2
Volatile Suspended Solids	mg/L													2
Turbidity	NTU	225				225								0.1
Fecal Coliform	mpn/100ml	200(30D)	200(30D)				200(30D)						200(30D)	<20
Total Coliform	mpn/100ml	1000,70(30D)	1000(30D)				1000(30D)						70(30D)	<20
Enterococcus	mpn/100ml	35(30D)	104(IM)(14)				35(30D)							<20
Aluminum	µg/L	750(1H)	750(1H)						750(1H)		1000		1000	100
Antimony	µg/L	1200	2.8	4300	4300		1200		1600	2.8	6	6	6	0.5
Arsenic	µg/L	69(1H)	340(1H), 2.1	69(1H)	340(1H)	32(DM)				2.1	50	50	50	1
Beryllium*	µg/L	0.033					0.033		5.3	14	4	4	4	0.5
Cadmium	µg/L	44(1H)	4.6(1H)	44(1H)	4.6(1H)	4(DM)	10(IM)			3.5	5	5	5	0.25
Chromium (total)	µg/L	20(IM)	50			20(IM)					50	100	50	0.5
Copper	µg/L	4.8(1H)	13(1H)	4.8(1H)	13(1H)	12(DM)					1300	1300		0.5
Hex. Chromium	µg/L	1111(1H)	16.3(1H)	1111(1H)	16.3(1H)	8(DM)				21				5

Table 8.2 Summary of Applicable Water Quality Benchmarks and Receiving Water Quality Criteria (Page 2 of 5). (continued)

Analytes	Units	Benchmarks		Water Quality Criteria										Lab. ML
				California Toxics Rule		California Ocean Plan (2)		USEPA Ambient Criteria		USEPA IRIS Reference Dose as a Drinking Water Level (4)	California Drinking Water Standard (5)	USEPA Drinking Water Standard (6)	Basin Plan (7)	
		Enclosed Bay & Estuary Discharge (Saltwater)	Inland Surface Water Discharge (Freshwater)	Saltwater (1A)	Freshwater (1B)	Saltwater Aquatic Life Protection	Consumption of Aquatic Organisms Only	Saltwater Aquatic Life Protection (3A)	Freshwater Aquatic Life Protection (3A)					
Iron	µg/L													100
Lead	µg/L	210(1H)	65(1H)	210(1H)	65(1H)	8(DM)					15	15		0.5
Mercury	µg/L	2.1(1H)	1.6(1H)	2.1(1H)	1.6(1H)	0.16(DM)					2	2	2	0.5
Nickel	µg/L	74(1H)	470(1H)	74(1H)	470(1H)	20(DM)				100	100		100	1
Selenium	µg/L	290(1H)	20(1H)	290(1H)	20(1H)	60(DM)				35	50	50	50	1
Silver	µg/L	1.9(1H)	3.4(1H)	1.9(1H)	3.4(1H)	2.8(DM)				35				0.25
Thallium	µg/L	6.3	6.3	6.3	6.3		2		40	0.6	2	2	2	1
Zinc	µg/L	90(1H)	120(1H)	90(1H)	120(1H)	80(DM)				2100				1
2-Chlorophenol	µg/L	400	400	400	400		10(IM)			35				2
2,4-Dichlorophenol	µg/L	790	790	790	790		10(IM)		365	21				1
2,4-Dimethylphenol	µg/L	2300	2300	2300	2300		300(IM)							2
2,4-Dinitrophenol	µg/L	14,000	14,000	14,000	14,000		4							5
2-Nitrophenol	µg/L	4850	230				300(IM)	4850	230					10
4-Nitrophenol	µg/L	4850	230				300(IM)	4850	230					5
4-Chloro-3-methylphenol	µg/L	10(IM)	30				10(IM)		30					1
Pentachlorophenol	µg/L	13(1H)	19(1H)	13(1H)	19(1H)					6				2
Phenol	µg/L	4,600,000	4,600,000	4,600,000	4,600,000	120(DM)			2560	4200				1
2,4,6-Trichlorophenol	µg/L	6,5	6.5	6.5	6.5		10(IM)							10
Acenaphthene	µg/L	2700	2700	2700	2700			970		420				1
Acenaphthylene*	µg/L	300	300				0.0088	300						2
Anthracene*	µg/L	110,000	110,000	110,000	110,000		0.0088			2100				2
Benzidine*	µg/L	0.00054	0.00054	0.00054	0.00054		0.000069							5
1,2 Benzanthracene*	µg/L	0.049	0.049	0.049	0.049		0.0088					0.1		5
Benzo(a)pyrene*	µg/L	0.049	0.049	0.049	0.049		0.0088				0.2	0.2	0.2	2
Benzo(g,h,i)perylene*	µg/L	0.0088	0.0088				0.0088							5
3,4 Benzofluoranthene*	µg/L						0.0088							10
Benzo(k)fluoranthene*	µg/L	0.049	0.049	0.049	0.049		0.0088							2
Bis(2-Chloroethoxyl)methane	µg/L	4.4					4.4							5
Bis(2-Chloroisopropyl)ether	µg/L	170,000	170,000	170,000	170,000		1200		122	280				2
Bis(2-Chloroethyl) ether*	µg/L	1.4	1.4	1.4	1.4		0.045		122					1
Bis(2-Ethylhexl) phthalate*	µg/L	5.9	5.9	5.9	5.9		3.5							5
4-Bromophenyl phenyl ether	µg/L	360	360						360					5
Butyl benzyl phthalate	µg/L	5200	5200	5200	5200			2,944	940	140				10
2-Chloroethyl vinyl ether	µg/L													1
2-Chloronaphthalene	µg/L	4300	4300					7.5		560				10
4-Chlorophenyl phenyl ether	µg/L													5
Chrysene*	µg/L	0.049	0.049	0.049	0.049		0.0088							5

Table 8.2 Summary of Applicable Water Quality Benchmarks and Receiving Water Quality Criteria (Page 3 of 5). (continued)

Analytes	Units	Benchmarks		Water Quality Criteria										Lab. ML
				California Toxics Rule		California Ocean Plan (2)		USEPA Ambient Criteria		USEPA IRIS Reference Dose as a Drinking Water Level (4)	California Drinking Water Standard (5)	USEPA Drinking Water Standard (6)	Basin Plan (7)	
		Enclosed Bay & Estuary Discharge (Saltwater)	Inland Surface Water Discharge (Freshwater)	Saltwater (1A)	Freshwater (1B)	Saltwater Aquatic Life Protection	Consumption of Aquatic Organisms Only	Saltwater Aquatic Life Protection (3A)	Freshwater Aquatic Life Protection (3A)					
Dibenzo(a,h)-anthracene	µg/L	0.049	0.049	0.049	0.049		0.0088							0.1
1,3-Dichlorobenzene	µg/L	2600	2600	2600	2600		5100	129	763					1
1,4-Dichlorobenzene*	µg/L	2600	2600	2600	2600		18	129	763		5	75	5	1
1,2-Dichlorobenzene	µg/L	17,000	17,000	17,000	17,000		5100	129	763	630	600	600	600	1
3,3-Dichlorobenzidine*	µg/L	0.077	0.077	0.077	0.077		0.0081							5
Diethylphthalate	µg/L	120,000	120,000	120,000	120,000		33,000	2944	940	5600				2
Dimethylphthalate	µg/L	2,900,000	2,900,000	2,900,000	2,900,000		820,000	2944	940					2
di-n-Butyl phthalate	µg/L	12,000	12,000	12,000	12,000		3500	2944	940	700				10
2,4-Dinitrotoluene*	µg/L	9.1	9.1	9.1	9.1		2.6		230	14				5
2,6-Dinitrotoluene	µg/L													5
4,6-Dinitro-2-methylphenol	µg/L	765	765	765	765		220							5
1,2-Diphenylhydrazine*	µg/L	0.54	0.54	0.54	0.54		0.16							1
di-n-Octyl phthalate	µg/L	2944	940					2944	940					10
Fluoranthene	µg/L	370	370	370	370		15	16		280				0.05
Fluorene	µg/L	14,000	14,000	14,000	14,000		0.0088			280				0.1
Hexachlorobenzene*	µg/L	0.00077	0.00077	0.00077	0.00077		0.00021				1	1	1	1
Hexachlorobutadiene*	µg/L	50	50	50	50		14	32	9.3					1
Hexachloro-cyclopentadiene	µg/L	17,000	17,000	17,000	17,000		58	7	5.2	42	50	50	50	5
Hexachloroethane*	µg/L	8.9	8.9	8.9	8.9		2.5		540	0.7				1
Indeno(1,2,3-cd)pyrene*	µg/L	0.049	0.049	0.049	0.049		0.0088							0.05
Isophorone*	µg/L	600	600	600	600		730			170				1
Naphthalene	µg/L	2350	2300					2350	2300	14				0.2
Nitrobenzene	µg/L	1900	1900	1900	1900		4.9			3.5				1
N-Nitroso-dimethyl amine*	µg/L	8.1	8.1	8.1	8.1		7.3							5
N-Nitroso-diphenyl amine*	µg/L	16	16	16	16		2.5							1
N-Nitroso-di-n-propylamine*	µg/L	1.4	1.4	1.4	1.4		0.38							5
Phenanthrene*	µg/L	0.0088	0.0088				0.0088							0.05
Pyrene*	µg/L	10	10	11,000	11,000		0.0088			210				0.05
1,2,4-Trichlorobenzene	µg/L	129	70					129		70	70	70		1
4,4'-DDD*	µg/L	0.00083	0.00083	0.00083	0.00083		0.00017							0.05
4,4'-DDE*	µg/L	0.00059	0.00059	0.00059	0.00059		0.00017							0.05
4,4'-DDT*	µg/L	0.13(IM)	1.1(IM)	0.13(IM)	1.1(IM)		0.00017	0.13(IM)	1.1(IM)	3.5				0.01
Aldrin*	µg/L	1.3(IM)	3(IM)	1.3(IM)	3(IM)		0.000022	1.3	3					0.005
alpha-BHC	µg/L	0.013	0.013	0.013	0.013	0.008(DM)								0.01
alpha-chlordane*	µg/L	0.09(IM)	2.4	0.09(IM)	2.4(IM)		0.000023	0.09	2.4	0.42	0.1	2		0.1
beta-BHC	µg/L	0.046	0.046	0.046	0.046	0.008(DM)								0.005
delta-BHC	µg/L	0.008(DM)	0.008(DM)			0.008(DM)								0.005
gamma-BHC (lindane)	µg/L	0.16(IM)	0.95(1H)	0.16(IM)	0.95(1H)	0.008(DM)		0.16(IM)	0.95(IM)	0.2				0.02
gamma-chlordane*	µg/L	0.09(IM)	2.4	0.09(IM)	2.4(IM)		0.000023	0.09	2.4	0.42	0.1	2		0.1

Table 8.2 Summary of Applicable Water Quality Benchmarks and Receiving Water Quality Criteria (Page 4 of 5). (continued)

Analytes	Units	Benchmarks		Water Quality Criteria										Lab. ML
				California Toxics Rule		California Ocean Plan (2)		USEPA Ambient Criteria		USEPA IRIS Reference Dose as a Drinking Water Level (4)	California Drinking Water Standard (5)	USEPA Drinking Water Standard (6)	Basin Plan (7)	
		Enclosed Bay & Estuary Discharge (Saltwater)	Inland Surface Water Discharge (Freshwater)	Saltwater (1A)	Freshwater (1B)	Saltwater Aquatic Life Protection	Consumption of Aquatic Organisms Only	Saltwater Aquatic Life Protection (3A)	Freshwater Aquatic Life Protection (3A)					
Dieldrin*	µg/L	0.71(IM)	0.24(1H)	0.71(IM)	0.24(1H)		0.00004	0.71(IM)	0.024(1H)					0.01
alpha-Endosulfan	µg/L	0.034(IM)	0.22(IM)	0.034(IM)	0.22(IM)	0.018(DM)		0.034(IM)	0.22(IM)	42				0.02
beta-Endosulfan	µg/L	0.034(IM)	0.22(IM)	0.034(IM)	0.22(IM)	0.018(DM)		0.034(IM)	0.22(IM)	42				0.01
Endosulfan sulfate	µg/L	240	240	240	240	0.018(DM)								0.05
Endrin	µg/L	0.037(IM)	0.086(1H)	0.037(IM)	0.086(1H)	0.004(DM)		0.037(IM)	0.086(1H)	2	2	2	2	0.01
Endrin aldehyde	µg/L	0.0018	0.0018											0.01
Heptachlor*	µg/L	0.053(IM)	0.52(IM)	0.053(IM)	0.52(IM)		0.00005	0.053(IM)	0.52(IM)		0.01	0.4	0.01	0.01
Heptachlor Epoxide*	µg/L	0.053(IM)	0.52(IM)	0.053(IM)	0.52(IM)		0.00002	0.053(IM)	0.52(IM)		0.01	0.2	0.01	0.01
Toxaphene*	µg/L	0.21(1H)	0.73(1H)	0.21(1H)	0.73(1H)		0.00021	0.21(1H)	0.73(1H)		3	3	3	0.5
Aroclor-1016*	µg/L	0.127	0.127				0.000019							0.5
Aroclor-1221*	µg/L	100	100				0.000019							0.5
Aroclor-1232*	µg/L	0.318	0.318				0.000019							0.5
Aroclor-1242*	µg/L	0.20	0.20				0.000019							0.5
Aroclor-1248*	µg/L	2.54	2.54				0.000019							0.5
Aroclor-1254*	µg/L	100	100				0.000019							0.5
Aroclor-1260*	µg/L	0.477	0.477				0.000019							0.5
Chlorpyrifos	µg/L	0.02$_{(10)}$	0.02$_{(10)}$					0.0056	0.041	21				0.05
Diazinon	µg/L		0.08$_{(10)}$											0.01
Prometryn	µg/L													2
Atrazine	µg/L		3.0							25	3	3	3	2
Simazine	µg/L		3.5							3.5	4	4	4	2
Cyanazine	µg/L													2
Malathion	µg/L		0.1					0.1	0.1	140				1
Glyphosate	µg/L		700							700	700	700	700	5
2,4-D	µg/L		70							70	70	70	70	0.02
2,4,5-TP (Silvex)	µg/L		50							53	50	50	50	0.2

Table 8.2 Summary of Applicable Water Quality Benchmarks and Receiving Water Quality Criteria (Page 5 of 5). (continued)

Footnotes

Table is based upon the California Regional Water Quality Control Board, Central Region's "Compilation of Water Quality Goals" (Marshack 2000) and draft analytical benchmarks being developed by San Diego's Project Clean Water, Science and Technology, Technical Advisory Committee.

(1) USEPA Recommended Ambient Water Quality Criteria – Acute (Instantaneous Maximum or 1 – Hour Average Maximum) Concentration, Freshwater Aquatic Life Protection.

(1A,1B) Numeric Criteria for Priority Toxic Pollutants for the State of California; California Toxics Rule, USEPA, 60 Federal Register (FR) 31681-31719, May 18, 2000. Values are "30-day Average Concentration for Human Health Protection (consumption of aquatic organisms only for both Saltwater & Freshwater)," unless indicated for (IM) for (Instantaneous Maximum or (1-H) for 1-Hour Average Maximum Concentration for Saltwater or Freshwater Aquatic Life Protection). The Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays and Estuaries of California (Phase 1 of the Inland Surface Water Plan and the Enclosed Bays and Estuaries Plan) was adopted by the State Water Resources Control Board on March 2, 2000 and effective on May 18,2000.

(2) Water Quality Control Plan for Ocean Waters of California (California Ocean Plan), California State Water Resources Control Board, adopted on November 16, 2000 and became effective on December 3, 2001. Values are 30-day Average Concentration for Human Health Protection (consumption of aquatic organisms only), unless indicated (IM) for (Instantaneous Maximum Concentration or (DM) for Daily Maximum Concentration).

(3) Secondary Treatment Regulations – 40 CFR 133.

(3A,3B) USEPA National Recommended Ambient Water Quality Criteria – Saltwater or Freshwater Aquatic Life Protection, Ambient Water Quality Criteria, various dates. Values are "Lowest Observed Effect Level (LOEL) concentrations for Chronic (24-Hour or 4 day Average) Concentration, Saltwater and Freshwater Aquatic Life Protection.

(4) USEPA Integrated Risk Information System (IRIS) Reference Dose (RfD) as a Drinking Water Level.

(5) Drinking Water Standards, Maximum Contaminant Levels – California (California Department of Health Services), California Code Regulations (CCR), Title 22, Division 4, Chapter 15, Domestic Water Quality and Monitoring.

(6) Drinking Water Standards, Maximum Contaminant Levels – Federal (USEPA), 40 Code of Federal Regulations (CFR) Parts 141 and 143.

(7) Los Angeles Regional Water Quality Control Board Basin Plan Water Quality Objectives.

(8) USEPA Recommended Ambient Water Quality Criteria – Human Health Protection (consumption of water and organisms).

(9) Factor of 4 times Biochemical Oxygen Demand (BOD – 5day) concentration – North Carolina benchmark.

(10) Freshwater Final Acute Values (FAV) California Department of Fish and Game, Water Quality Criteria for Diazinon and Chlorpyrifos (April 26, 2002).

(11) USEPA Recommended Ambient Water Quality Criteria – Lowest Observed Effect Level (LOEL) Concentration for Acute Toxicity, Freshwater Aquatic Life Protection.

(12) Median concentration of Stormwater Effluent Limitation Guideline – 40 CFR Part 419.

(13) National Urban Runoff Program (NURP) median concentration.

(14) AB411 Instantaneous Max

* Carcinogen

Table 8.3. Stormwater Monitoring Chemistry Statistics for Each Watershed. (Page 1 of 5)

ANALYTE	Belmont Pump					Bouton Creek					Los Cerritos Channel				
	No. of Samples	Percent Detect	Mean	Median	CV	No. of Samples	Percent Detect	Mean	Median	CV	No. of Samples	Percent Detect	Mean	Median	CV
CONVENTIONALS															
BOD5 (mg/L)	7	71	21	21	0.13	6	100	20	16	0.48	8	100	24	19	0.54
COD (mg/L)	7	100	96	81	0.44	6	100	105	88	0.45	8	100	136	100	0.60
Total Organic Carbon (mg/L)	7	100	49	17	1.35	6	100	37	20	0.93	8	100	29	21	0.63
Conductance (umhos/cm)	7	100	405	299	0.60	6	100	534	306	0.86	8	100	122	105	0.38
Total Hardness (mg/L)	7	100	126	97	0.55	6	100	125	74	0.84	8	100	70	49	0.66
Alkalinity, as CaCO3 (mg/L)	7	100	59	45	0.57	6	100	26	24	0.25	8	100	40	26	0.74
PH (units)	7	100	7.3	7.3	0.05	6	100	7.0	7.0	0.08	8	100	7.2	7.2	0.03
Cyanide (ug/L)	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Chloride (mg/L)	7	100	73	48	0.73	6	100	143	66	1.08	8	100	17	9.3	0.94
Fluoride (mg/L)	7	100	0.57	0.30	0.94	6	83	0.68	0.34	1.01	8	75	0.34	0.28	0.49
Total Kjeldahl Nitrogen (mg/L)	7	100	6.2	3.1	1.01	6	100	5.0	2.7	0.93	8	100	7.1	4.0	0.86
Total Ammonia-Nitrogen (mg/L)	7	100	0.92	0.70	0.56	6	100	0.97	0.71	0.60	8	100	0.90	0.78	0.40
Nitrite Nitrogen (mg/L)	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Nitrate Nitrogen (mg/L)	7	100	2.7	1.0	1.29	6	100	1.8	0.90	1.01	8	100	1.4	0.95	0.68
Total Phosphorus (mg/L)	7	100	1.4	0.77	0.91	6	100	0.89	0.47	0.95	8	100	1.9	0.99	0.95
Dissolved Phosphorus (mg/L)	7	100	0.40	0.30	0.57	6	100	0.29	0.13	1.09	8	100	0.27	0.19	0.63
MBAS (mg/L)	7	100	0.18	0.13	0.60	6	100	0.23	0.19	0.51	8	100	0.17	0.11	0.73
MTBE (ug/L)	6	0	ID	ID	ID	6	33	1.3	1.3	0.11	8	13	ID	ID	ID
Total Phenols (mg/L)	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Oil & Grease (mg/L)	6	33	37	14	1.24	6	0	ID	ID	ID	9	33	22	12	0.89
TRPH (mg/L)	6	17	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Total Suspended Solids (mg/L)	7	100	602	135	1.86	6	100	476	105	1.88	8	100	516	303	0.84
Total Dissolved Solids (mg/L)	7	100	251	191	0.56	6	100	344	199	0.85	8	100	106	90	0.41
Turbidity (NTU)	7	100	167	73	1.14	6	100	88	69	0.53	8	100	183	137	0.58
BACTERIA (mpn/100ml)															
Fecal Coliform	5	80	658,331	24,868	5.05	6	83	32,324	11,518	1.34	9	100	67,000	28,217	1.17
Total Coliform	5	40	259,109	53,478	1.96	6	67	64,167	34,736	0.92	9	56	189,575	120,346	0.76

Table 8.3. Stormwater Monitoring Chemistry Statistics for Each Watershed. (Page 2 of 5)

ANALYTE	Belmont Pump					Bouton Creek					Los Cerritos Channel				
	No. of Samples	Percent Detect	Mean	Median	CV	No. of Samples	Percent Detect	Mean	Median	CV	No. of Samples	Percent Detect	Mean	Median	CV
TOTAL METALS (ug/L)															
Aluminum	7	100	3215	1187	1.31	6	100	1697	934	0.90	8	100	2768	1850	0.70
Arsenic	7	100	3.2	2.5	0.53	6	100	2.6	2.08	0.52	8	88	4.9	4.1	0.45
Beryllium	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Cadmium	7	71	2.1	1.5	0.62	6	67	1.3	1.0	0.49	8	100	2.6	1.9	0.63
Chromium	7	100	8.9	4.6	0.96	6	100	5.3	3.6	0.67	8	100	10	6.0	0.82
Hexavalent Chromium (mg/L)	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Copper	7	100	93	57	0.79	6	100	45	28	0.77	8	100	44	38	0.39
Iron	7	100	4251	1213	1.58	6	100	1732	1217	0.65	8	100	5473	2876	0.95
Mercury	7	0	ID	ID	ID	6	33	0.39	0.34	0.36	8	13	ID	ID	ID
Nickel	7	100	21	9.6	1.08	6	100	9.3	6.3	0.69	8	100	13	11	0.45
Lead	7	100	129	49	1.27	6	100	64	26	1.19	8	100	105	57	0.91
Zinc	7	100	731	369	0.99	6	100	592	248	1.18	8	100	842	544	0.74
DISSOLVED METALS (ug/L)															
Aluminum	7	71	109	61	0.89	6	67	103	77	0.59	8	88	182	136	0.58
Arsenic	7	100	1.4	1.3	0.33	6	100	1.1	1.1	0.17	8	88	1.4	1.3	0.21
Beryllium	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Cadmium	7	43	0.29	0.29	0.04	6	ID	ID	ID	ID	8	25	0.54	0.34	0.77
Chromium	7	71	1.3	1.2	0.29	6	33	1.9	1.1	0.82	8	88	1.3	1.2	0.34
Copper	7	100	14	11	0.58	6	100	10	9.3	0.30	8	100	10	8.5	0.42
Iron	7	71	273	105	1.26	6	83	307	145	1.06	8	88	306	169	0.90
Mercury	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Nickel	7	100	6.4	4.0	0.77	6	100	3.9	2.8	0.63	8	100	4.2	3.4	0.50
Lead	7	86	2.1	1.9	0.30	6	100	2.6	2.2	0.46	8	75	1.8	1.6	0.40
Zinc	7	100	98	65	0.71	6	100	84	63	0.57	8	100	78	67	0.41
CHLORINATED PESTICIDES (ug/L)															
4,4'-DDD	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
4,4'-DDE	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
4,4'-DDT	7	14	ID	ID	ID	6	ID	ID	ID	ID	8	0	ID	ID	ID
Aldrin	7	14	ID	ID	ID	6	ID	ID	ID	ID	8	25	0.08	0.07	0.08
Alpha-BHC	7	14	ID	ID	ID	6	ID	ID	ID	ID	8	13	ID	ID	ID
Alpha-Chlordane	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
beta-BHC	7	0	ID	ID	ID	6	0	ID	ID	ID	8	13	ID	ID	ID
Delta-BHC	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Dieldrin	7	0	ID	ID	ID	6	0	ID	ID	ID	8	13	ID	ID	ID

Table 8.3. Stormwater Monitoring Chemistry Statistics for Each Watershed. (Page 3 of 5)

ANALYTE	Belmont Pump No. of Samples	Belmont Pump Percent Detect	Belmont Pump Mean	Belmont Pump Median	Belmont Pump CV	Bouton Creek No. of Samples	Bouton Creek Percent Detect	Bouton Creek Mean	Bouton Creek Median	Bouton Creek CV	Los Cerritos Channel No. of Samples	Los Cerritos Channel Percent Detect	Los Cerritos Channel Mean	Los Cerritos Channel Median	Los Cerritos Channel CV
CHLORINATED PESTICIDES (ug/L) (continued)															
Endosulfan Sulfate	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Endrin	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Endrin Aldehyde	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
gamma-BHC (lindane)	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
gamma-Chlordane	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Heptachlor	7	0	ID	ID	ID	6	0	ID	ID	ID	8	25	0.01	0.01	0.06
Heptachlor Epoxide	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Total PCBs	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Toxaphene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
AROCLORS (ug/L)															
Arochlor 1016	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Arochlor 1221	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Arochlor 1232	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Arochlor 1242	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Arochlor 1248	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Arochlor 1254	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Arochlor 1260	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
ORGANOPHOSPHATE PESTICIDES (ug/L)															
Atrazine	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Dursban (chlorpyrifos)	7	29	0.12	0.10	0.46	6	ID	ID	ID	ID	8	25	0.30	0.29	0.07
Cyanazine	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Diazinon	7	43	2.8	1.9	0.70	6	33	0.43	0.42	0.02	8	38	0.35	0.31	0.36
Malathion	7	43	1.3	1.3	0.12	6	0	ID	ID	ID	8	13	ID	ID	ID
Prometryn	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Simazine	7	0	ID	ID	ID	6	ID	ID	ID	ID	8	13	ID	ID	ID
HERBICIDES (ug/L)															
2,4,5-TP (Silvex)	7	0	ID	ID	ID	6	0	ID	ID	ID	8	13	ID	ID	ID
2,4-D	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Glyphosate	7	29	13	11	0.44	6	ID	ID	ID	ID	8	38	106	24	1.86

Table 8.3. Stormwater Monitoring Chemistry Statistics for Each Watershed. (Page 4 of 5)

ANALYTE	Belmont Pump No. of Samples	Belmont Pump Percent Detect	Belmont Pump Mean	Belmont Pump Median	Belmont Pump CV	Bouton Creek No. of Samples	Bouton Creek Percent Detect	Bouton Creek Mean	Bouton Creek Median	Bouton Creek CV	Los Cerritos Channel No. of Samples	Los Cerritos Channel Percent Detect	Los Cerritos Channel Mean	Los Cerritos Channel Median	Los Cerritos Channel CV
SEMIVOLATILE ORGANICS (ug/L)															
1,2,4-Trichlorobenzene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
1,2-Dichlorobenzene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
1,2-Diphenylhydrazine	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
1,3-Dichlorobenzene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
1,4-Dichlorobenzene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
2,4,6-Trichlorophenol	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
2,4-Dichlorophenol	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
2,4-Dimethylphenol	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
2,4-Dinitrophenol	7	0	ID	ID	ID	6	ID	ID	ID	ID	8	25	6.5	6.3	0.18
2,4-Dinitrotoluene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
2,6-Dinitrotoluene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
2-Chloronaphthalene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
2-Chlorophenol	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
2-Nitrophenol	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
3,3'-Dichlorobenzidine	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
4-Bromophenyl Phenyl Ether	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
4-Chloro-3-Methylphenol	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
4-Chlorophenyl Phenyl Ether	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
4-Nitrophenol	7	29	1.7	1.6	0.13	6	33	7.7	3.5	1.08	8	25	6.1	6.1	0.05
Acenaphthene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Anthracene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Benzidine	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Benzo(a)Anthracene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Benzo(a)Pyrene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Benzo(b)Fluoranthene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Benzo(k)Fluoranthene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Bis(2-chloroethoxy)Methane	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Bis(2-chloroethyl)Ether	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Bis(2-Ethylhexyl)Phthalate	7	71	13	12	0.29	6	83	32	11	1.40	8	75	23	17	0.57
Chrysene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Dibenzo(a,h)Anthracene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Diethyl Phthalate	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Dimethyl Phthalate	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Di-n-Butyl Phthalate	7	29	2.13	1.96	0.29	6	ID	ID	ID	ID	8	13	ID	ID	ID
Di-n-Octyl Phthalate	7	14	ID	ID	ID	6	33	6.0	2.2	1.30	8	25	4.4	4.4	0.02
Fluoranthene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID

Table 8.3. Stormwater Monitoring Chemistry Statistics for Each Watershed. (Page 5 of 5)

ANALYTE	Belmont Pump					Bouton Creek					Los Cerritos Channel				
	No. of Samples	Percent Detect	Mean	Median	CV	No. of Samples	Percent Detect	Mean	Median	CV	No. of Samples	Percent Detect	Mean	Median	CV
SEMIVOLATILE ORGANICS (ug/L) (continued)															
Fluorene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Hexachlorobenzene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Hexachlorobutadiene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Hexachlorocyclopentadiene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Hexachloroethane	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Indeno(1,2,3-c,d)Pyrene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Isophorone	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Naphthalene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Nitrobenzene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
N-Nitrosodi-n-Propylamine	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
N-Nitrosodiphenylamine	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Pentachlorophenol	7	29	15	3.5	1.82	6	0	ID	ID	ID	8	0	ID	ID	ID
Phenanthrene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Pyrene	7	0	ID	ID	ID	6	0	ID	ID	ID	8	0	ID	ID	ID
Phenol	7	0	ID	ID	ID	6	0	ID	ID	ID	8	13	ID	ID	ID

Table 8.4 Number of Measurements of Microbiological Indicator Organisms and Percent of Samples Exceeding Ocean Plan and AB411 Reference Values during Extended Dry Weather Periods from 1997 through 2001.

	May 1-Sep 15, 1997			May 16-Nov 1, 1998			Jun 15-Nov 5,1999			Apr 20-Oct 10, 2000			Apr 24-Nov 12, 2001		
	n[1]	OP (%)[2]	AB411 (%)[3]	n	OP (%)	AB411 (%)	n	OP (%)	AB411 (%)	n	OP (%)	AB411 (%)	n	OP (%)	AB411 (%)
Total Coliform															
B27	4	0	0	6	0	0	5	0	0	6	0	0	5	0	0
B28	5	0	0	6	0	0	5	0	0	6	0	0	7	0	0
B67							22	9	0	24	8	0	29	3	0
B29							22	0	0	25	8	4	30	3	3
B14	9	0	0	11	0	0	21	0	0	22	5	0	30	10	0
Fecal Coliform or E. coli[4]															
B27							5	0	0	6	0	0	5	0	0
B28							5	0	0	6	0	0	7	0	0
B67							22	5	0	26	12	4	29	0	0
B29							22	0	0	25	12	4	30	3	0
B14							21	0	0	25	4	0	30	0	0
Enterococcus															
B27	4	0													
B28	3	0													
B67							24	21	17	27	7	7	29	7	0
B29							20	0	0	26	12	0	30	10	0
B14							22	5	5	25	44	24	30	13	0

1. n=number of measurements during time period
2. OP= Ocean Plan 30-day average
   - Total Coliforms: 1000 per 100 ml
   - Fecal Coliforms: 200 per 100 ml
   - Enterococcus: 35 per 100 ml
3. AB411=Assembly Bill 411 Single Sample Criteria
   - Total Coliforms: 10,000 per 100 ml
   - Total Coliforms: 1000 per 100 ml if ratio of fecal to total coliforms is greater than 0.1
   - Fecal Coliforms: 400 per 100 ml
   - Enterococcus: 104 per 100 ml
4. *Escherichia coli* was used as surrogate for fecal coliform from January 2000 through June 12, 2001. Since a correction factor was not available, *E. coli* measurements were compared directly with Fecal Coliform criteria.

Table 8.5. Summary of Toxicity Characteristics of Stormwater from Various Southern California Watersheds. Test Types: SF = sea urchin fertilization, MS = mysid survival/growth, DS = daphnid survival/reproduction.

Location	Date	Test Type	Number of Samples	%Toxic	TUc
Long Beach	2001	SF	22	86	≤2-32
Long Beach	2001	MS	20	55	1-16
Long Beach	2001	DS	22	77	1->16
Los Angeles River	1997-99	SF	4	100	4-8
San Gabriel River	1997-99	SF	4	50	≤2-4
Ballona Creek	1996-97	SF	13	85	≤4-32
Chollas Creek	1999-2000	SF	5	100	8-32
Chollas Creek	1999	MS	3	0	1
Chollas Creek	1999	DS	3	67	1-2

Table 8.6. Summary of TIE Results for Each Sample. The primary toxicant category indicates the chemical class most strongly indicated by the results. The secondary category indicates the chemical class indicated from partially effective TIE treatments.

Date	Station	Water Flea		Mysid		Sea Urchin	
		Primary Category[a]	Secondary Category[a]	Primary Category	Secondary Category	Primary Category	Secondary Category
2/23/01	Cerritos					METAL	PARTICLE
4/7/01	Belmont					METAL	NPO
4/7/01	Cerritos					METAL	NPO
11/12/01	Belmont	OP	METAL	NPO			
11/13/01	Bouton						
11/12/01	Cerritos	OP	METAL				
11/24/01	Belmont	OP		NPO		METAL	
11/24/01	Bouton					METAL	
11/24/01	Cerritos	OP	PARTICLE			METAL	
5/9/02	Cerritos					METAL	

[a] OP = organophosphate pesticide, METAL = divalent trace metal, NPO = unspecified nonpolar organic, PARTICLE = toxicity associated with particulate fraction of sample.

Table 8.7. Nonparametric Spearman Correlation Coefficients showing the Relationship between Change in Chemical Concentration and Toxic Units for the Sea Urchin and Water Flea Toxicity Tests. Toxic units are based on the EC50 (sea urchin fertilization, water flea reproduction) or LC50 (water flea survival). Values in bold are statistically significant at $p \leq 0.05$ (*) or $p \leq 0.01$ (**). N=22 for all constituents except for chlorpyrifos and diazinon, where n=6.

Constituent		Sea Urchin Fertilization TUa	Water Flea Survival TUa	Water Flea Reproduction TUa
TSS		-0.18	**0.55****	**0.60****
TDS		-0.18	0.35	0.33
TOC		0.05	**0.79****	**0.79****
Cadmium	Dissolved	0.24	**0.78****	**0.77****
Chromium	Dissolved	0.22	**0.49***	0.42
Copper	Dissolved	**0.46***	0.23	0.08
Lead	Dissolved	0.12	**0.42***	0.36
Nickel	Dissolved	0.22	**0.86****	**0.79****
Zinc	Dissolved	**0.54****	**0.59****	**0.49***
Chlorpyrifos		0.28	0.15	0.15
Diazinon		-0.12	0.54	0.54

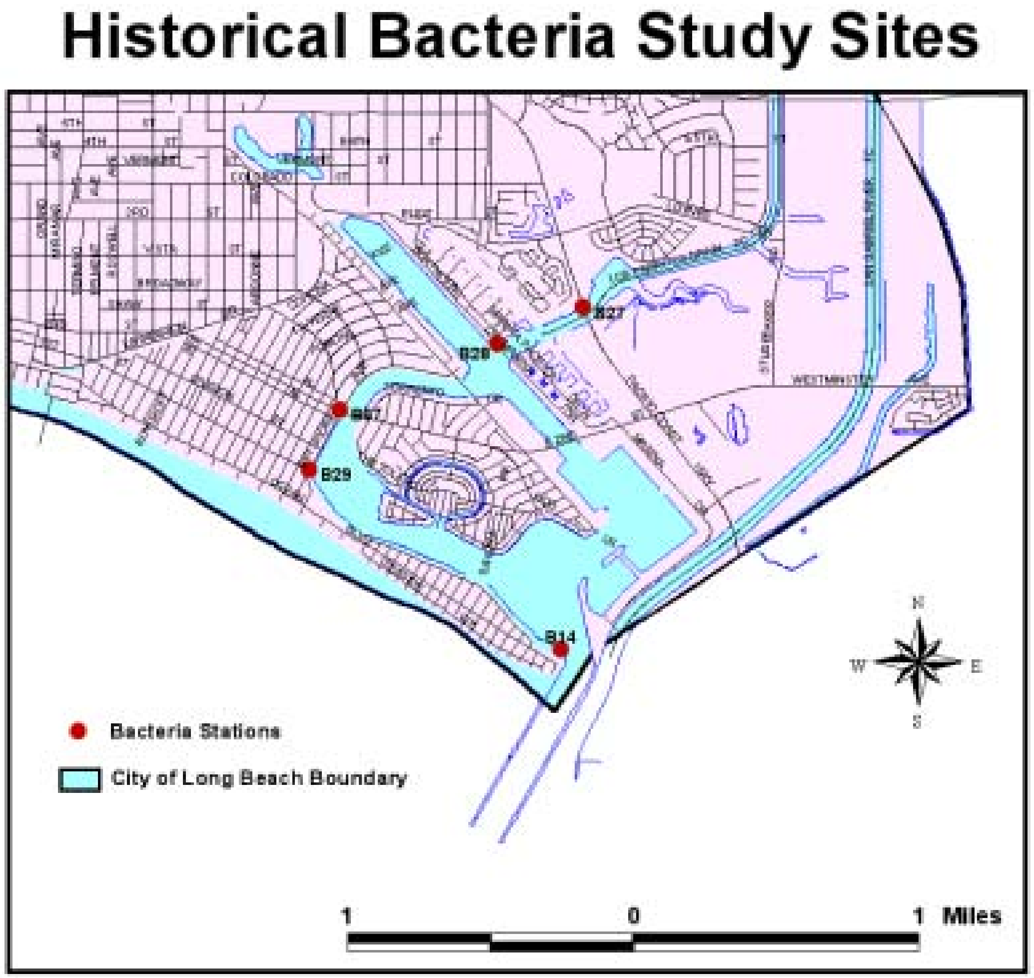


Figure 8.1. **Location of City of Long Beach Department of Health and Human Service's Microbiological Monitoring Sites.**

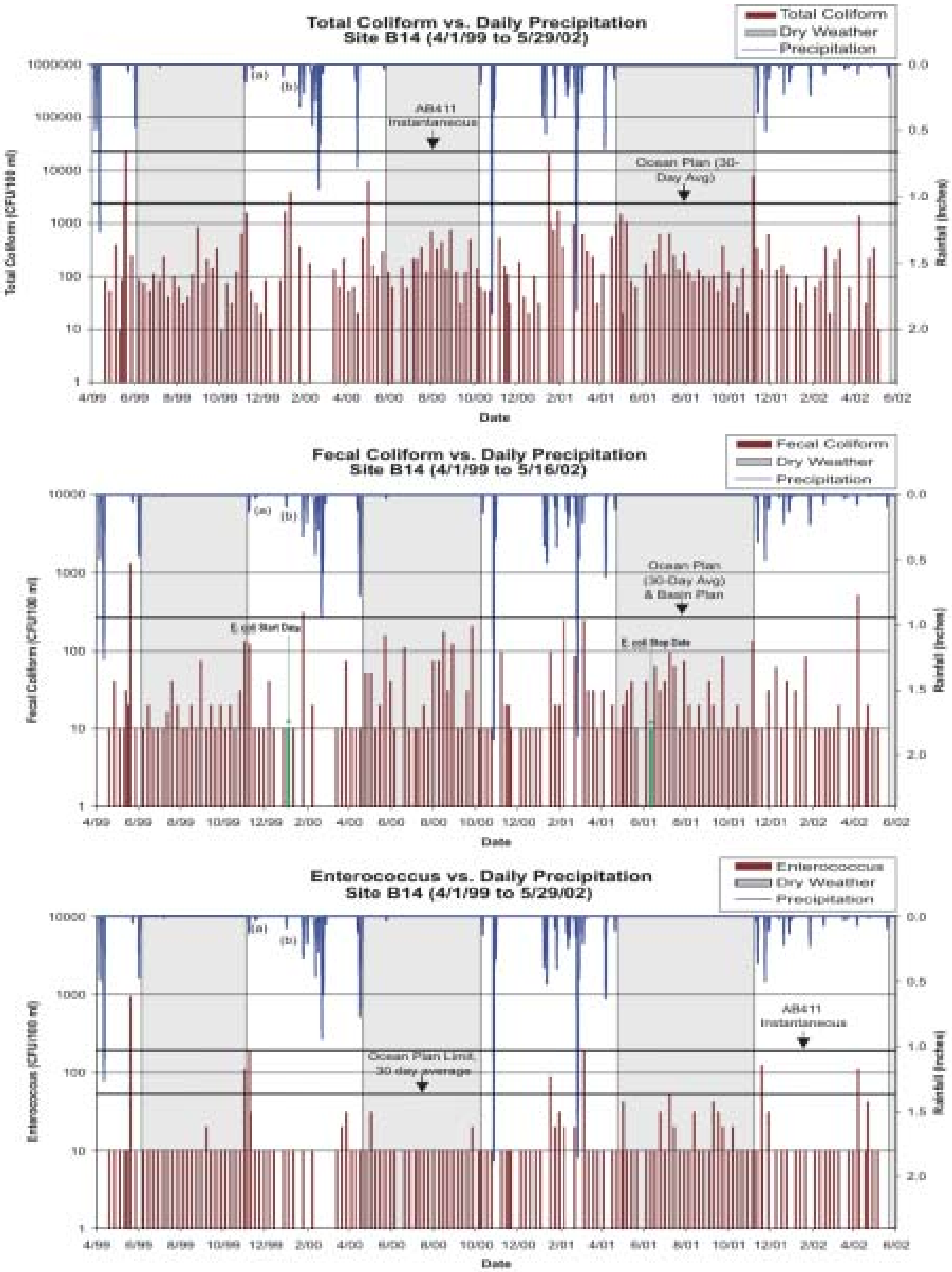


Figure 8.2. Bacterial Time Series for City of Long Beach Alamitos Bay Bacteria Station B14 (Bayshore Float).

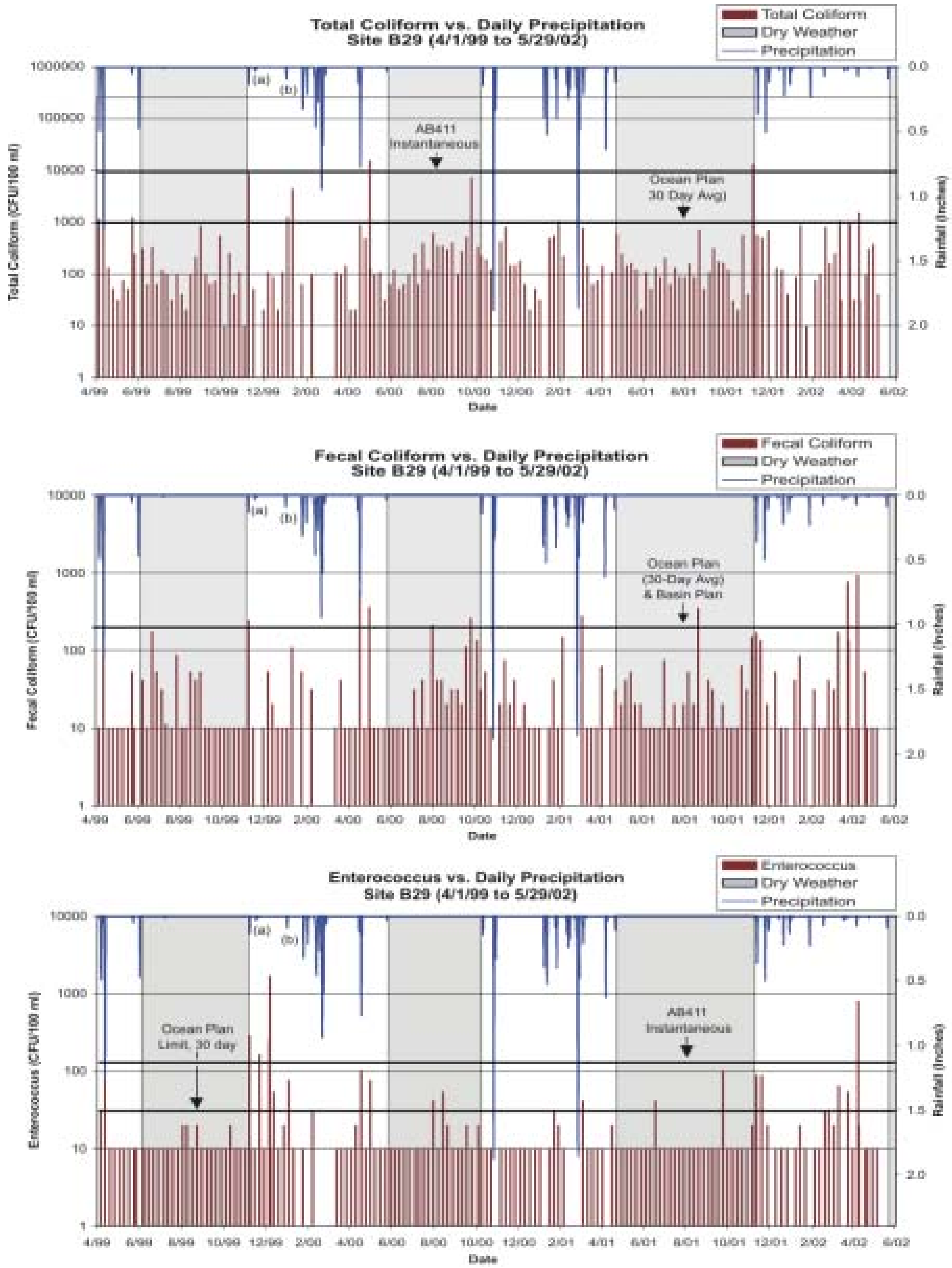


Figure 8.3. Bacterial Time Series for City of Long Beach Alamitos Bay Bacteria Station B29 (Bayshore and First).

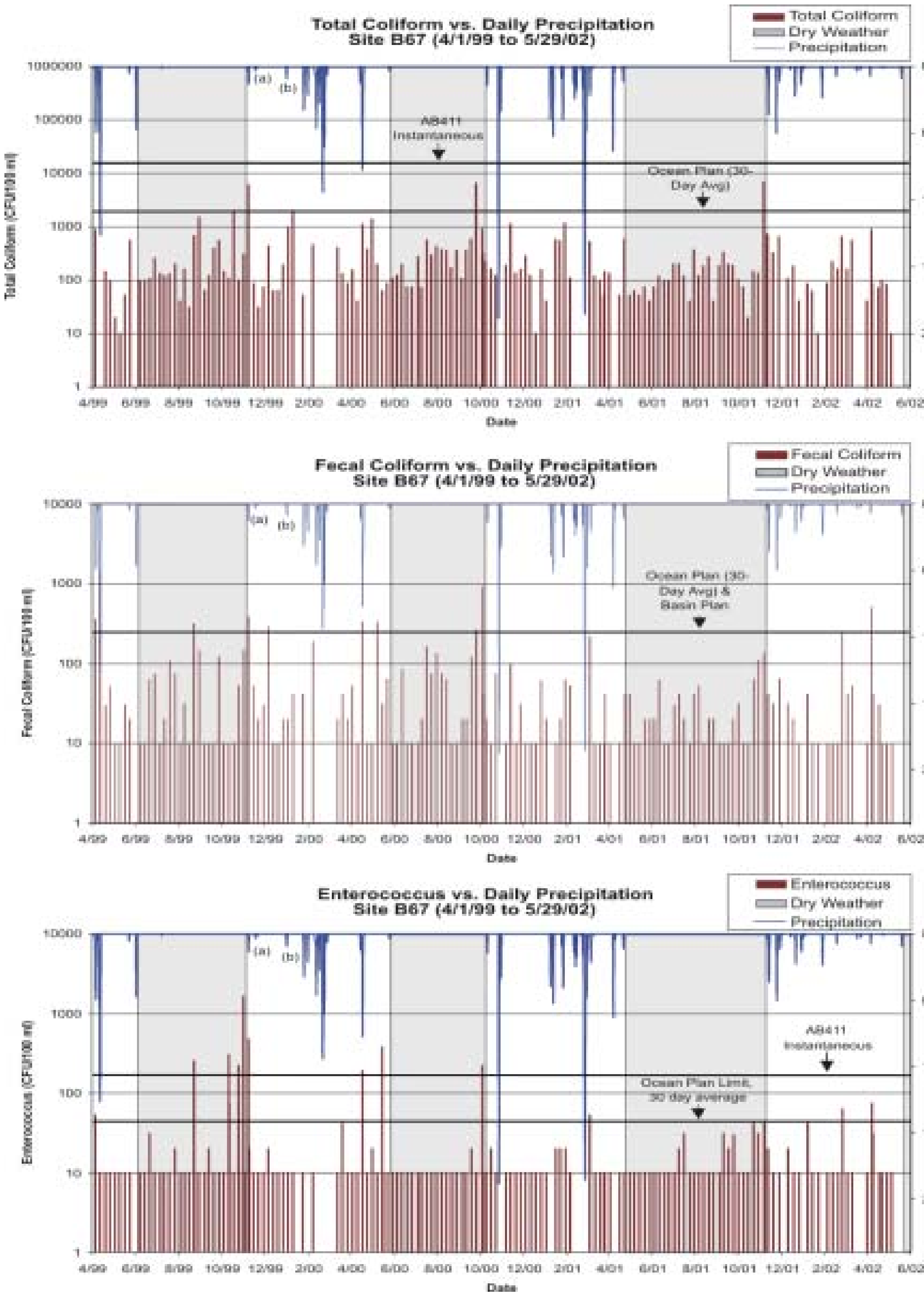


Figure 8.4. Bacterial Time Series for City of Long Beach Alamitos Bay Bacteria Station B67 (Bayshore and Second Street Bridge).

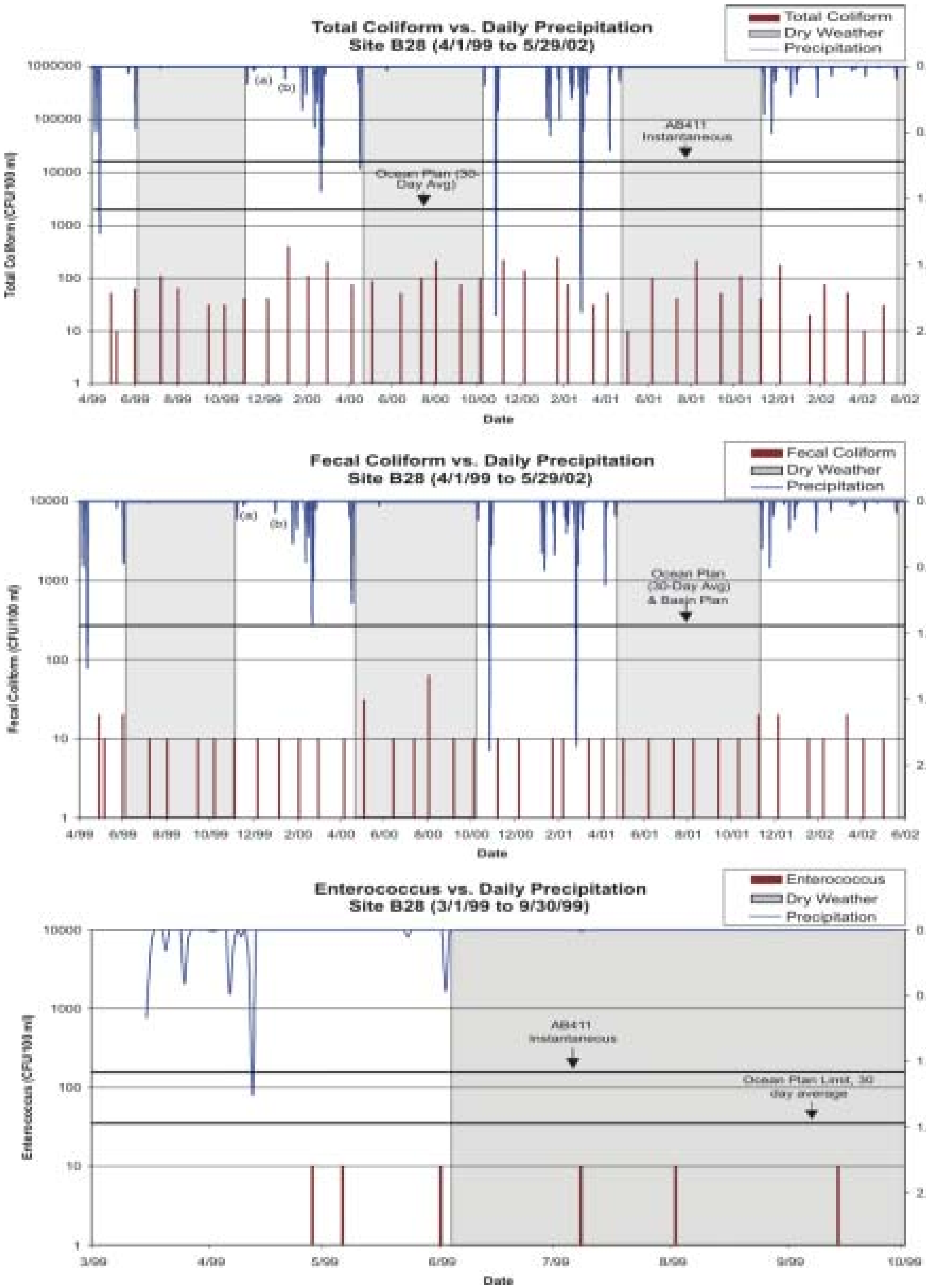


Figure 8.5. Bacterial Time Series for City of Long Beach Rowing Association Bacteria Station B28 (Los Cerritos Channel and Marine Stadium).

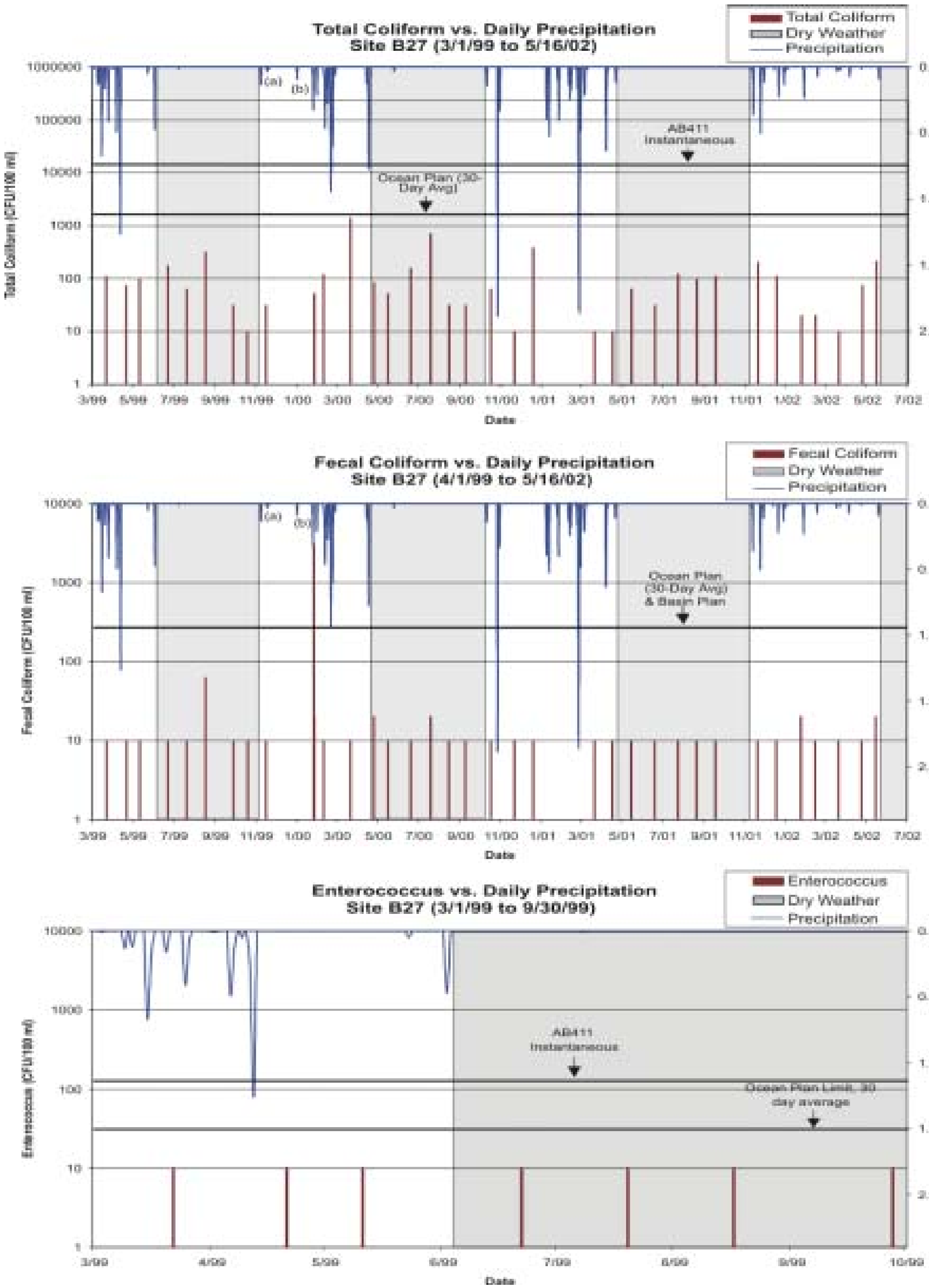
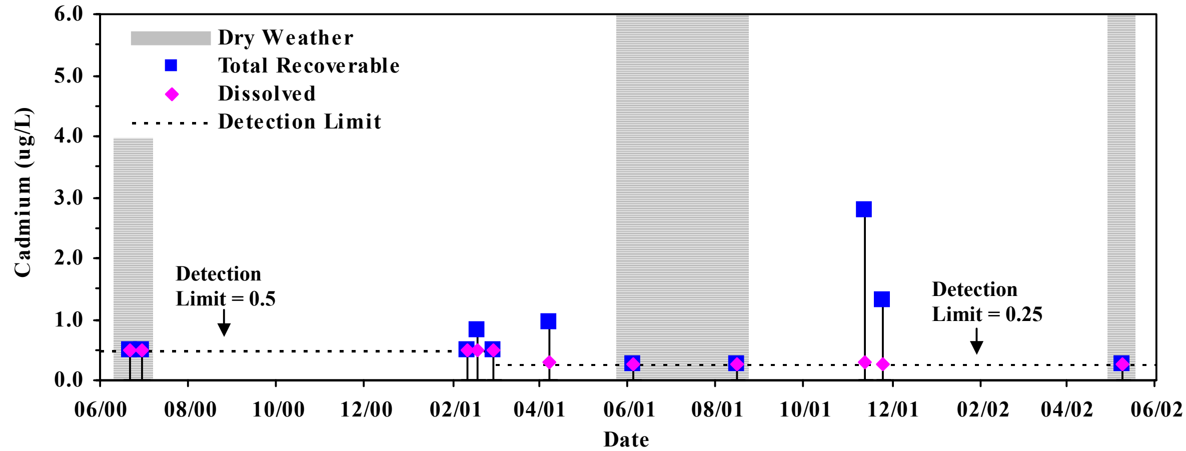


Figure 8.6. **Bacterial Time Series for City of Long Beach Los Cerritos Channel Bacteria Station B27 (Los Cerritos Channel and Pacific Coast Highway).**



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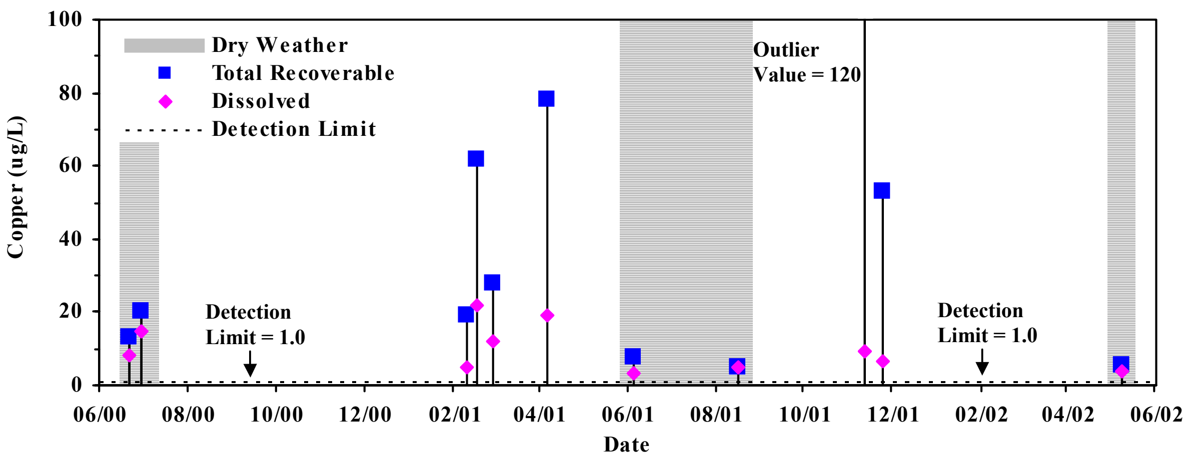

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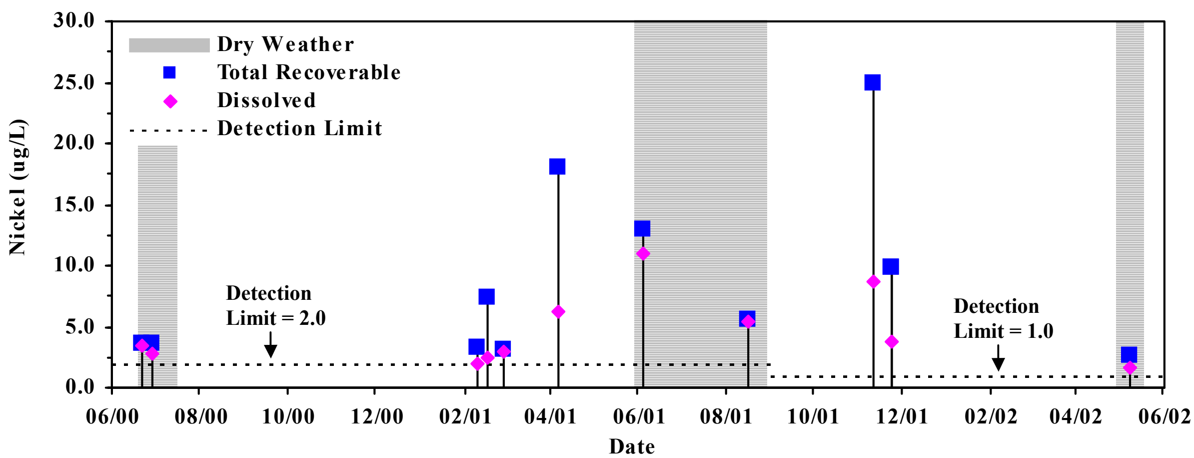
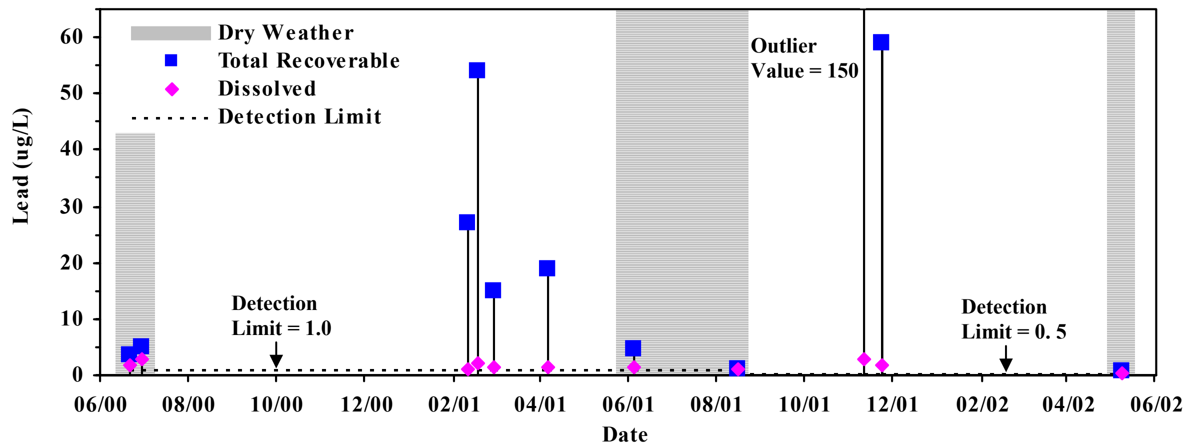


c)

Figure 8.7 Belmont Pump Chemistry Results: a) Cadmium; b) Copper; c) Nickel.



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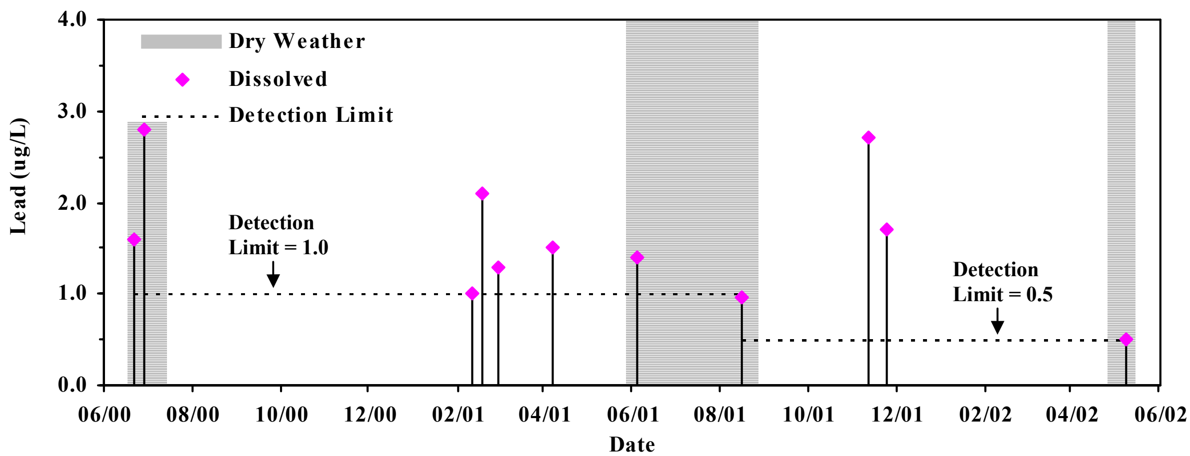

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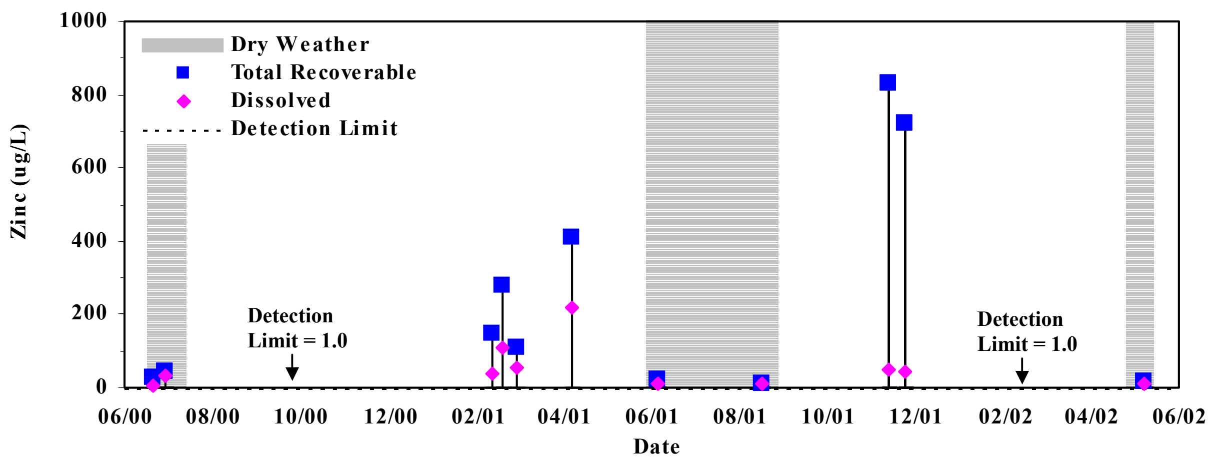
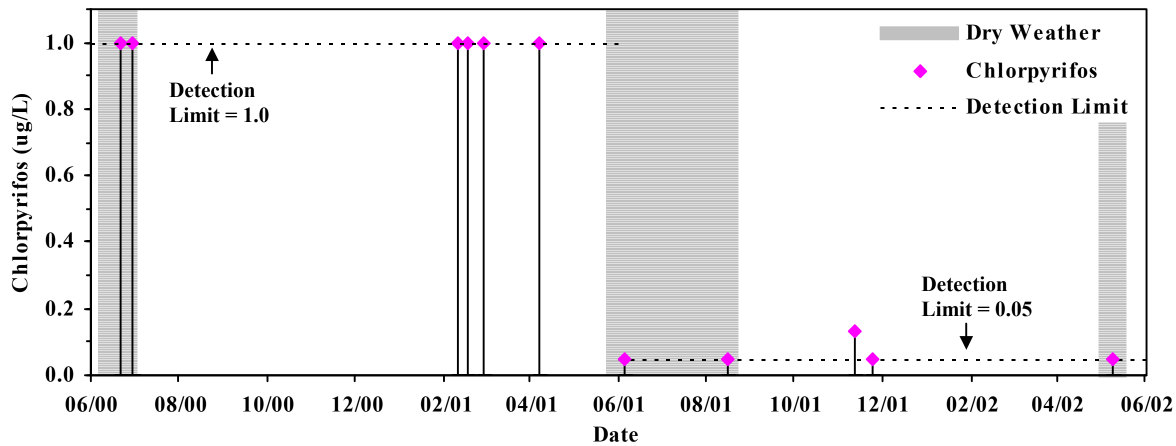


c)

Figure 8.8 Belmont Pump Chemistry Results: a) Lead (Total and Dissolved); b) Lead (Dissolved); c) Zinc.



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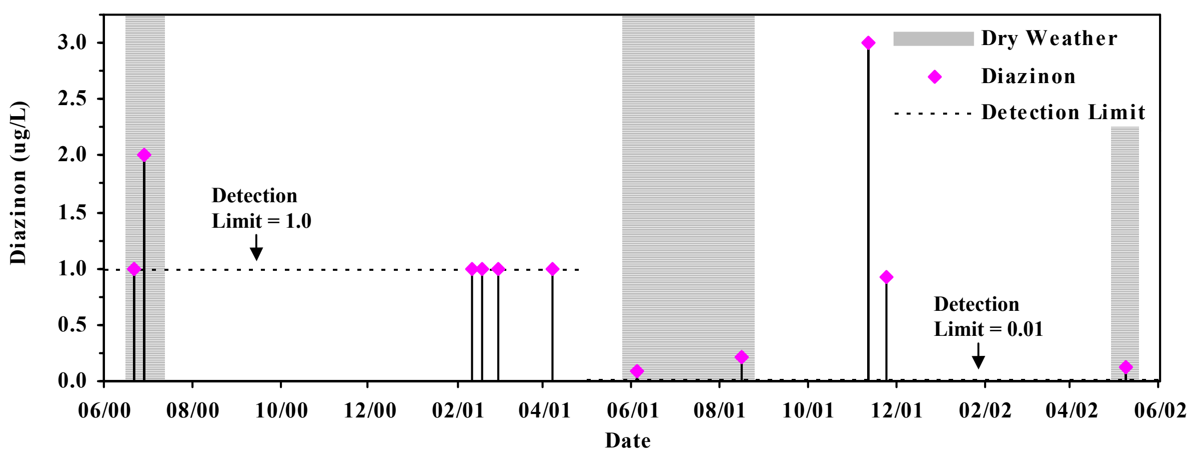
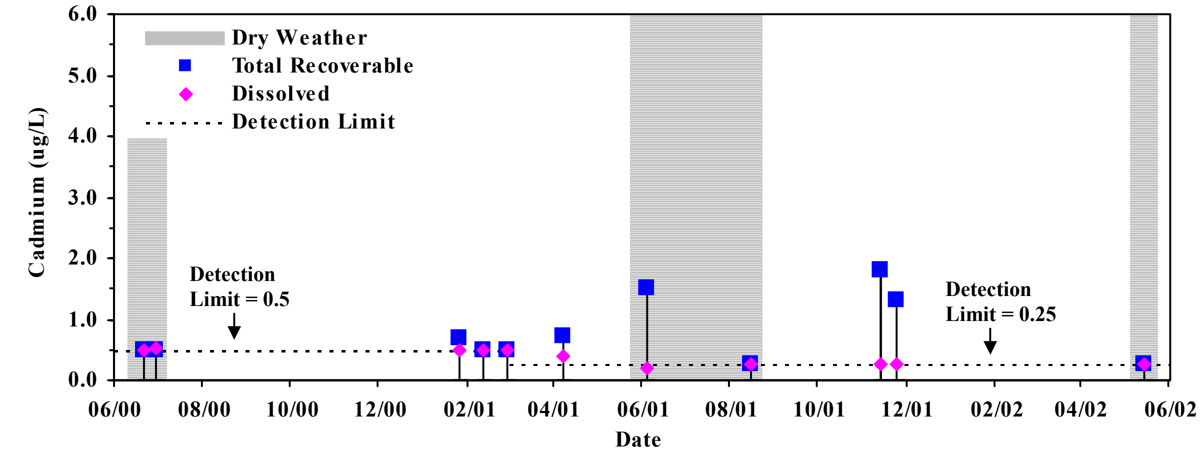


b)

Figure 8.9 Belmont Pump Chemistry Results: a) Chlorpyrifos; b) Diazinon.



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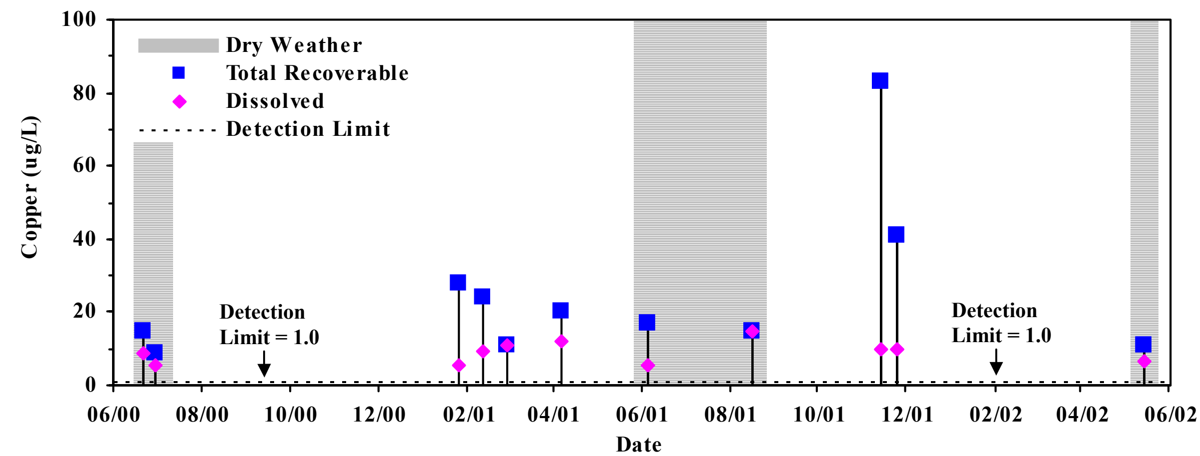

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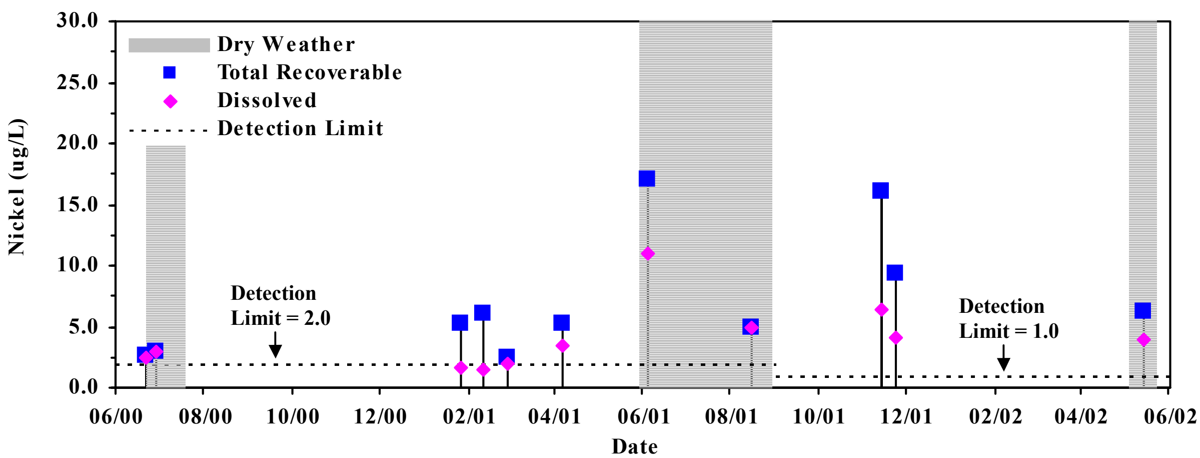
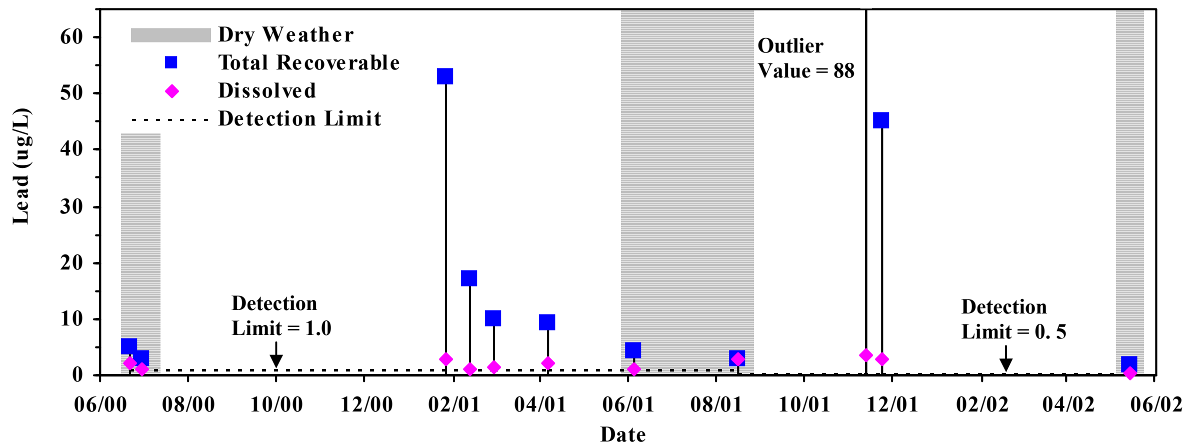


c)

Figure 8.10 Bouton Creek Chemistry Results: a) Cadmium; b) Copper; c) Nickel.



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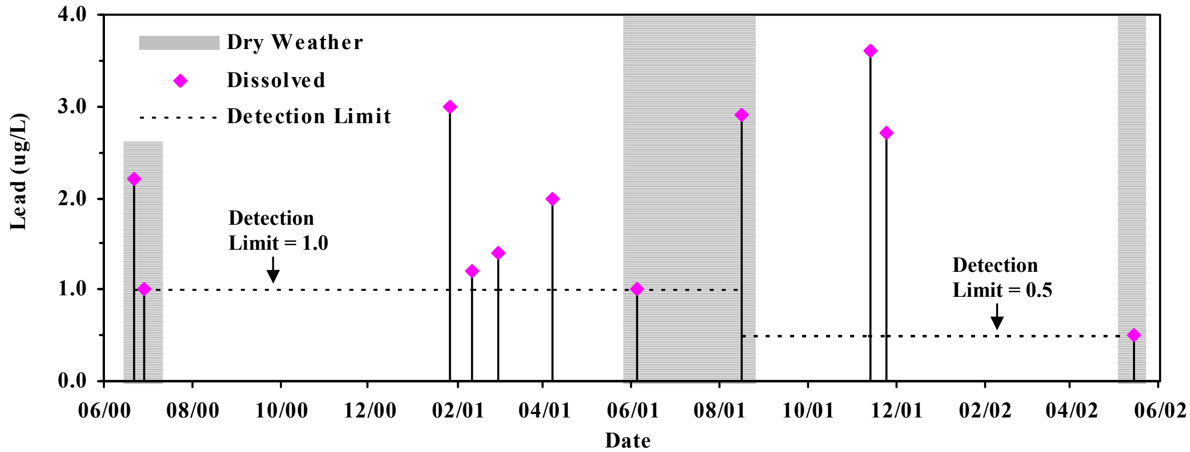

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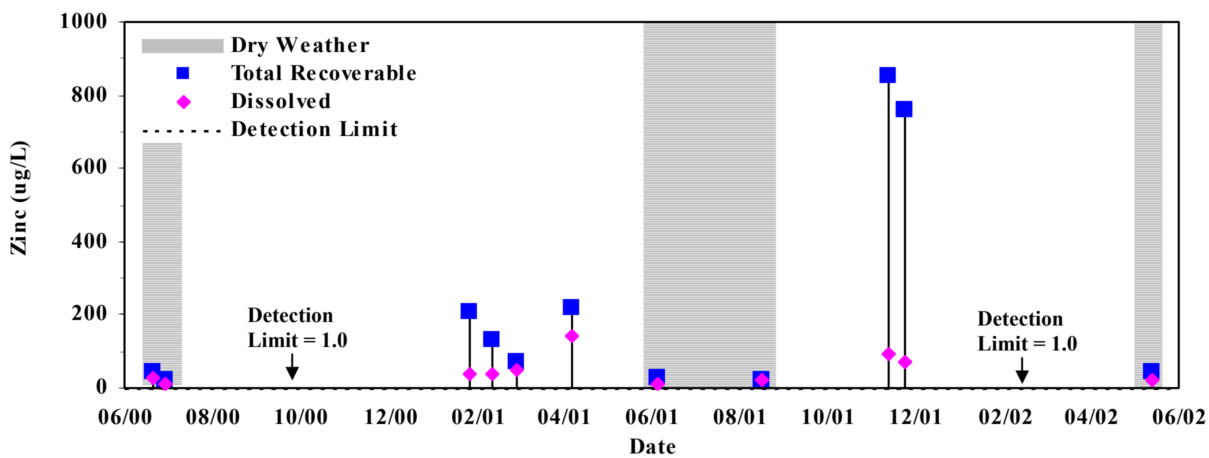
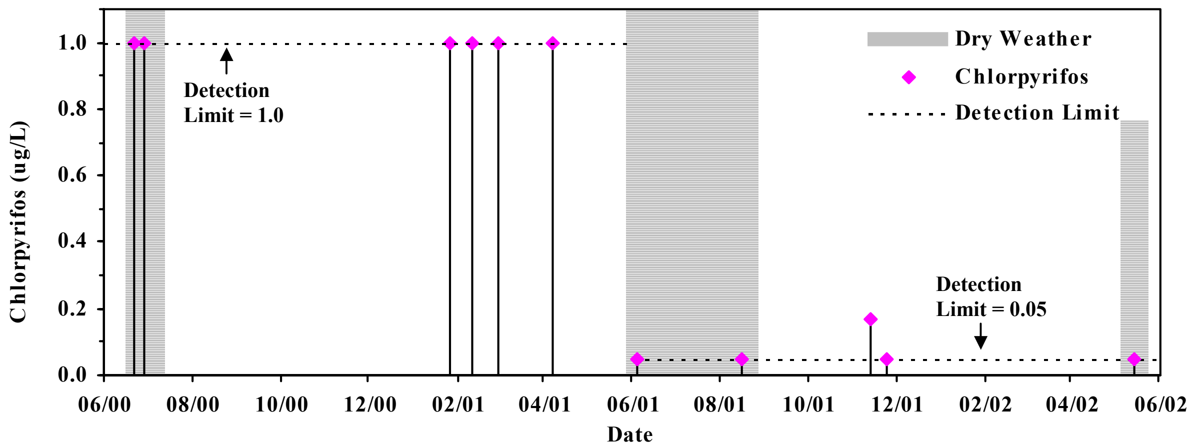


c)

Figure 8.11 Bouton Creek Chemistry Results: a) Lead (Total and Dissolved); b) Lead (Dissolved); c) Zinc.



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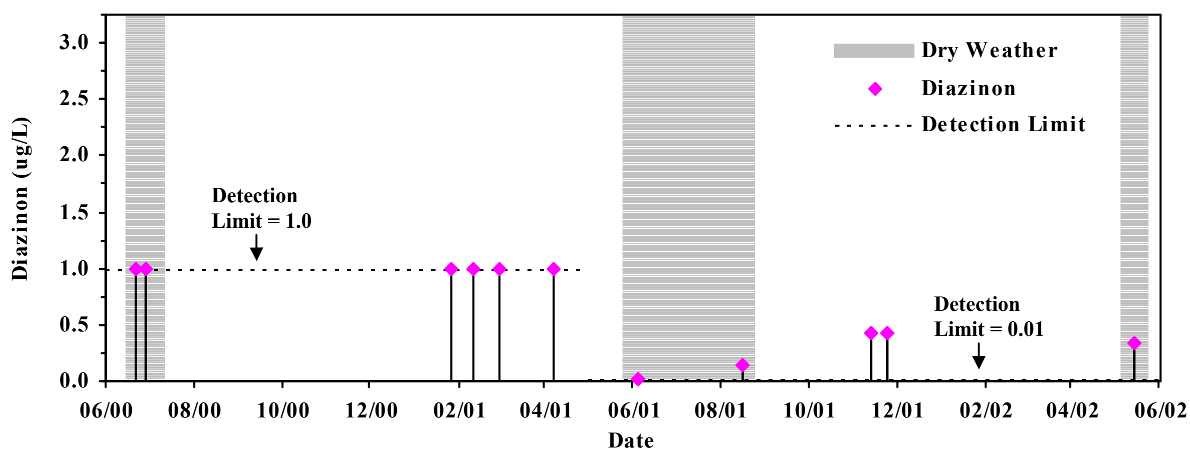


b)

Figure 8.12 Bouton Creek Chemistry Results: a) Chlorpyrifos; b) Diazinon.

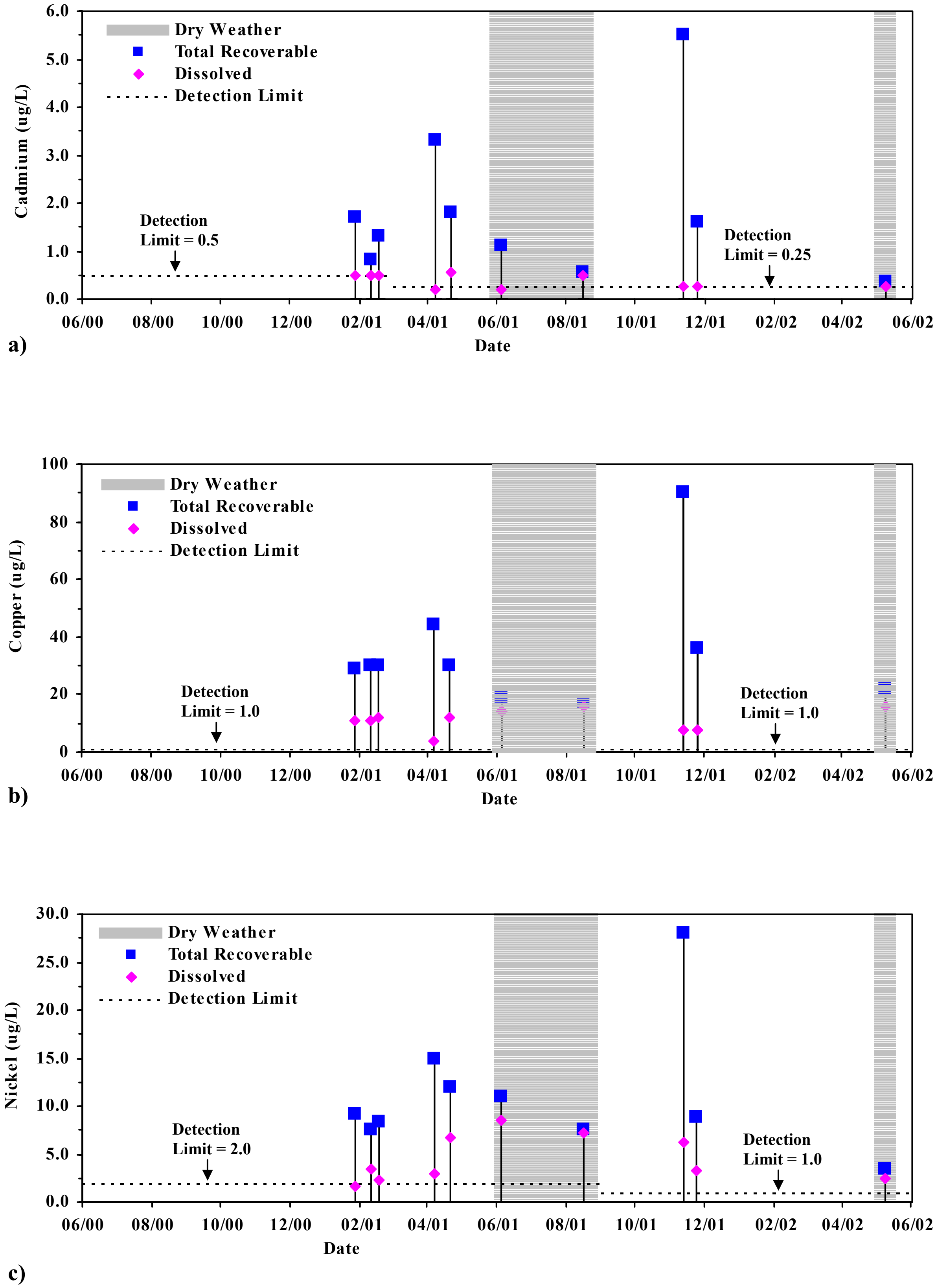
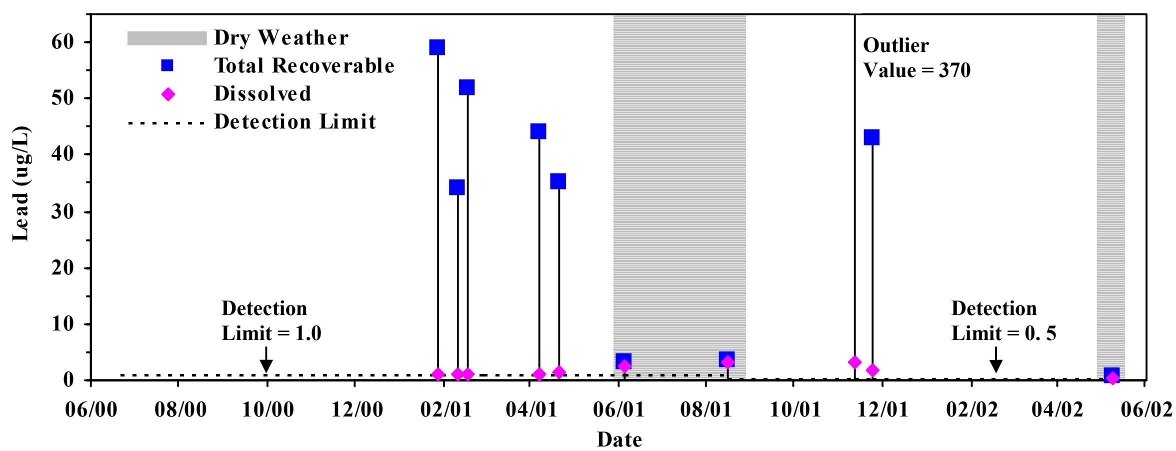


Figure 8.13 Los Cerritos Channel Chemistry Results: a) Cadmium; b) Copper; c) Nickel.



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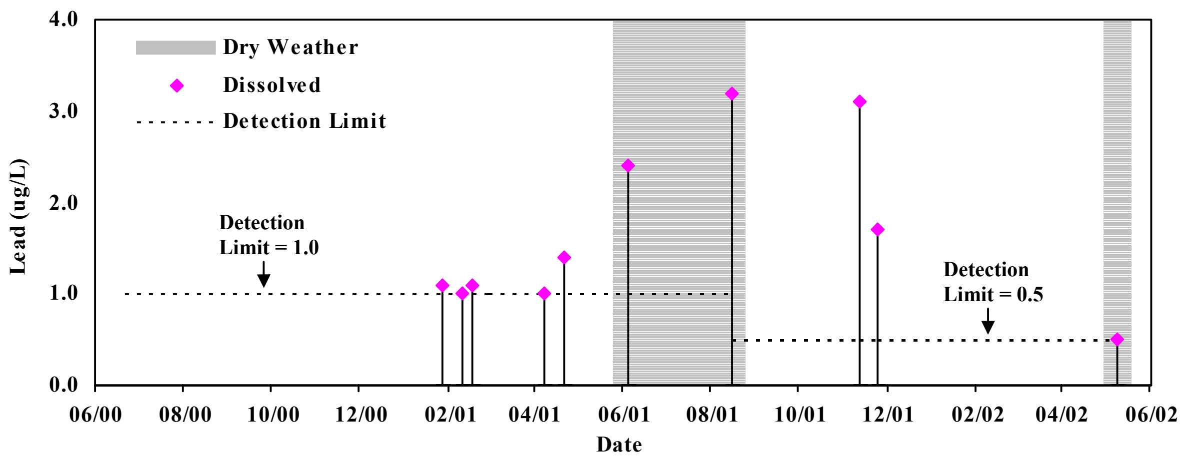

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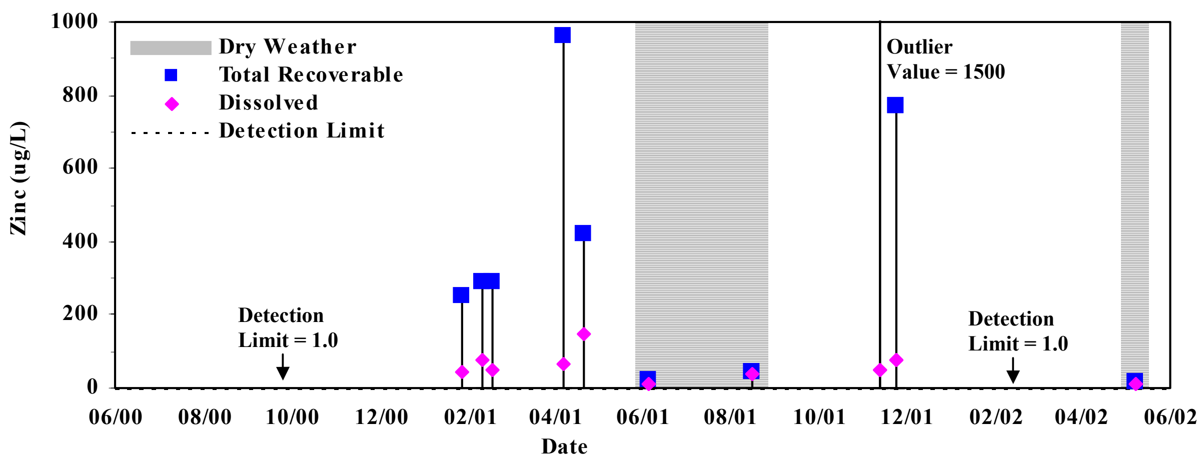
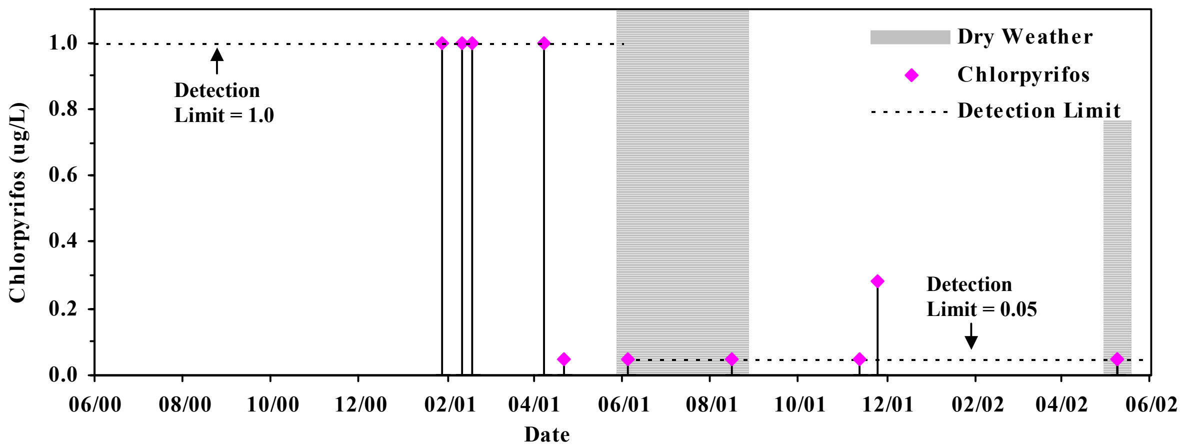


c)

Figure 8.14 Los Cerritos Channel Chemistry Results: a) Lead (Total and Dissolved); b) Lead (Dissolved); c) Zinc.



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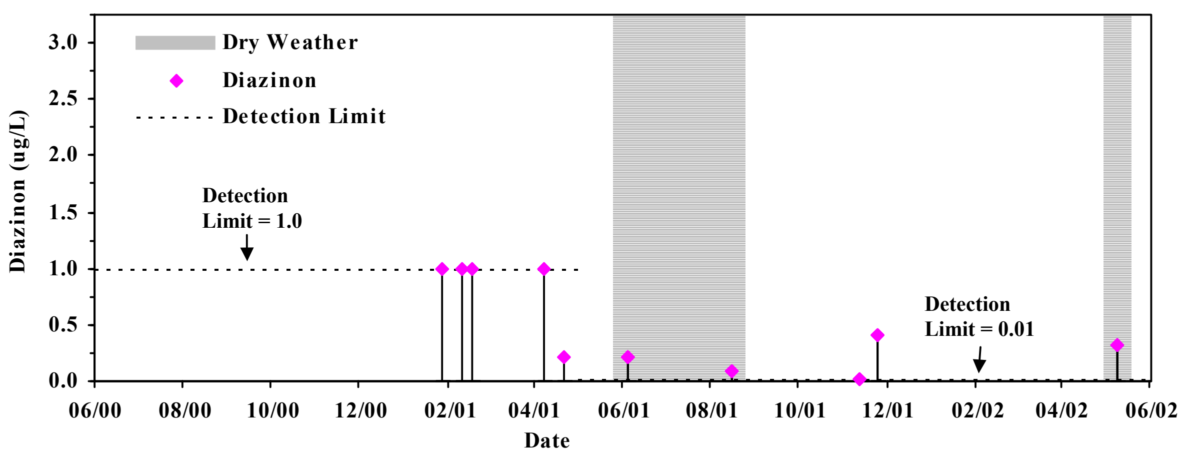
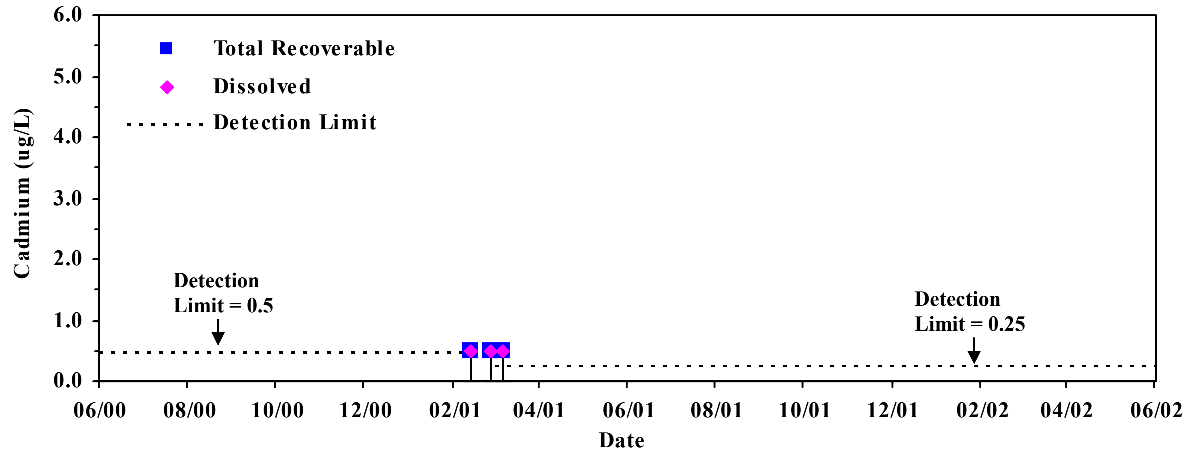


b)

Figure 8.15 Los Cerritos Channel Chemistry Results: a) Chlorpyrifos; b) Diazinon.



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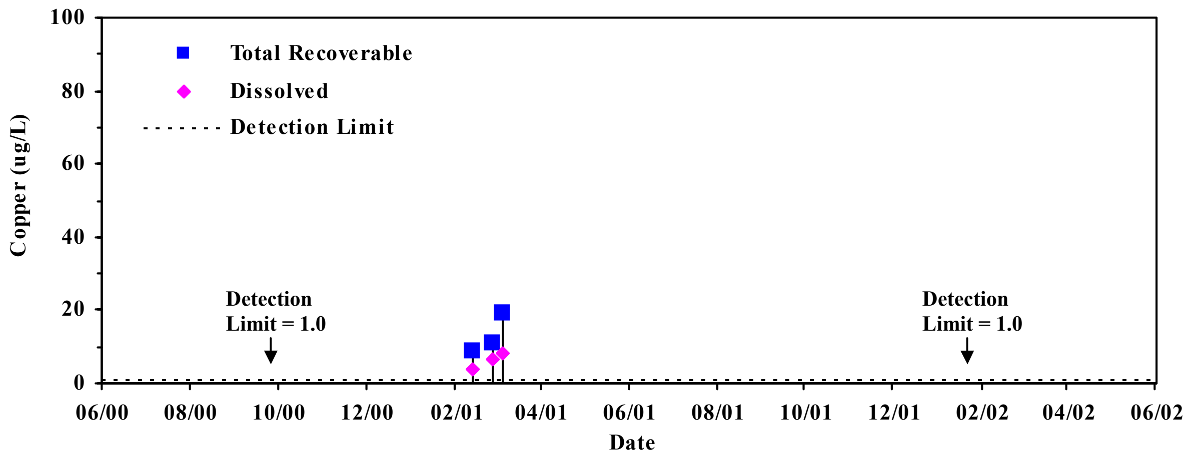

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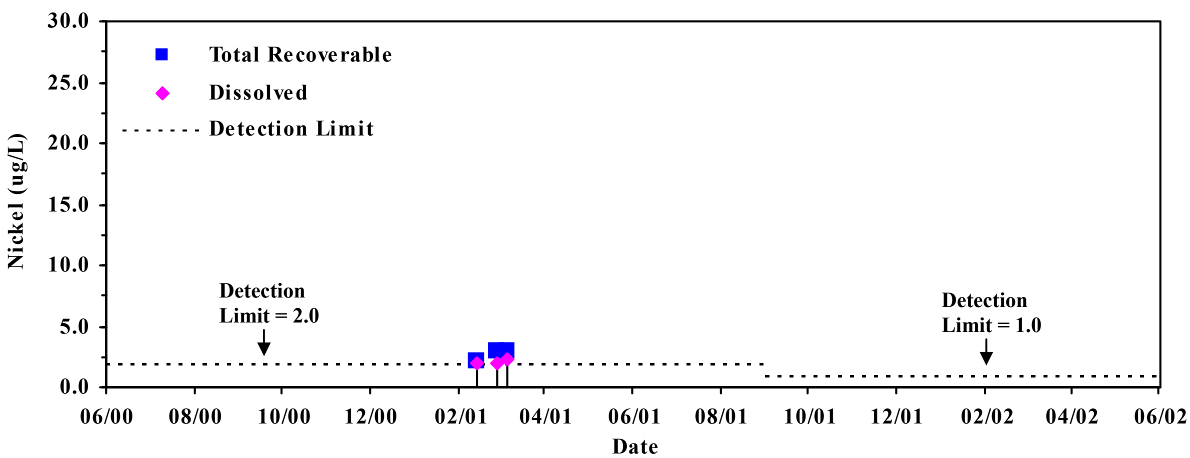
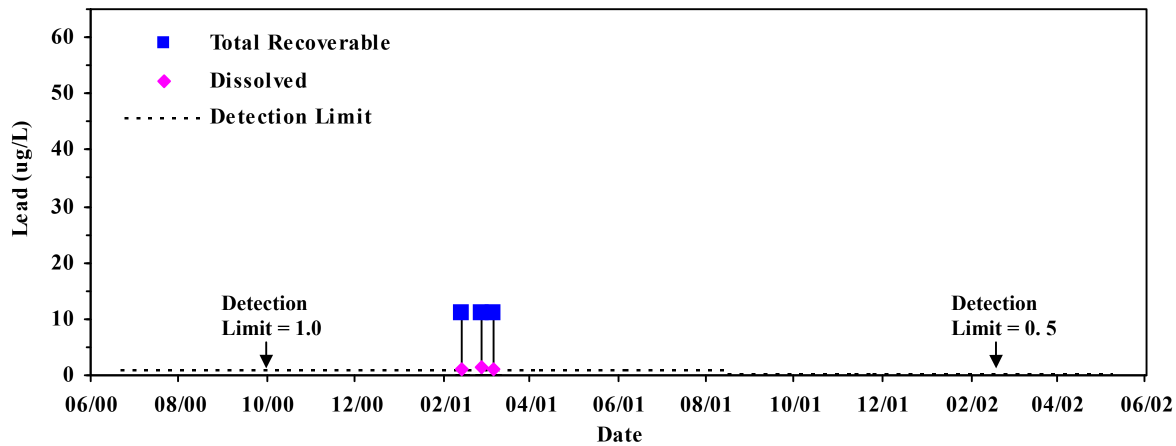


c)

Figure 8.16 Dominguez Pump Chemistry Results: a) Cadmium; b) Copper; c) Nickel.



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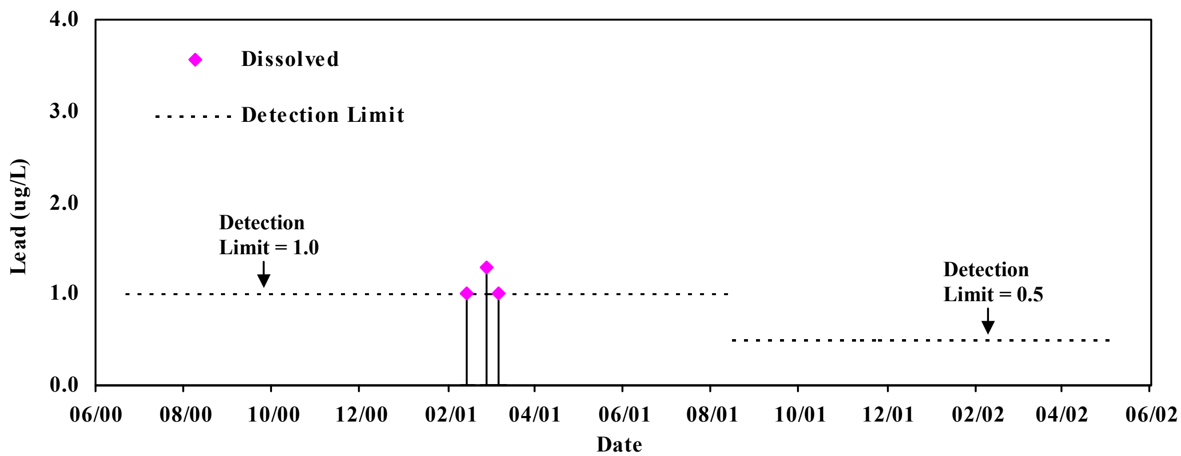

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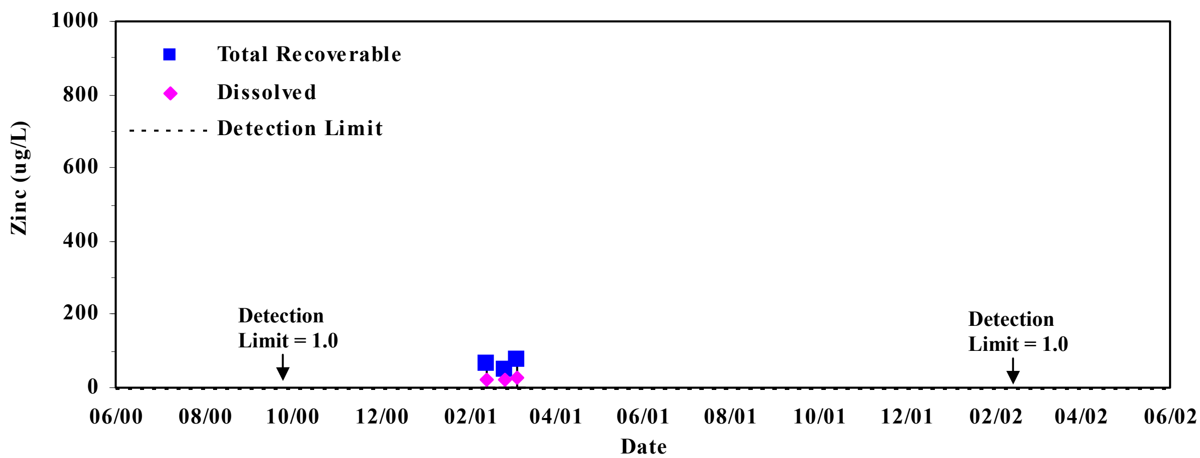
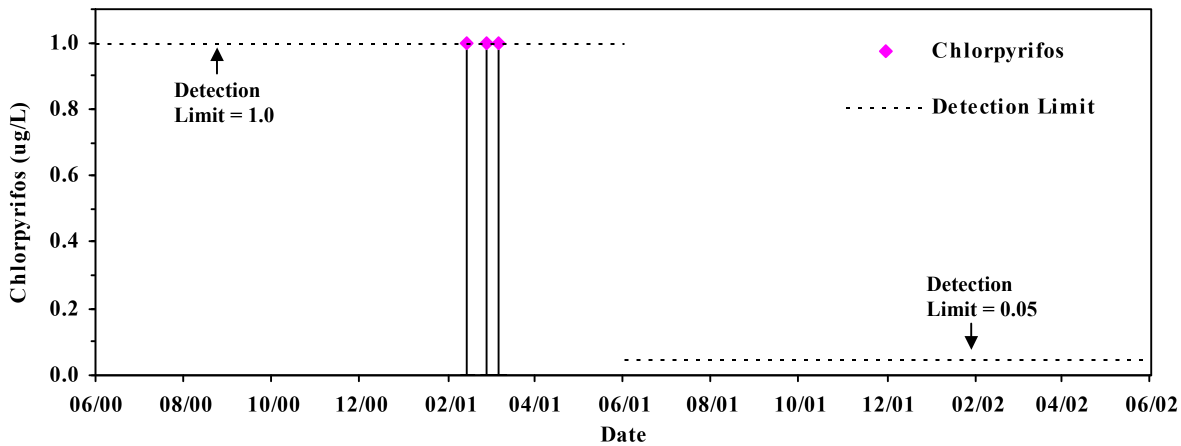


c)

Figure 8.17 Dominguez Pump Chemistry Results: a) Lead (Total and Dissolved); b) Lead (Dissolved); c) Zinc.



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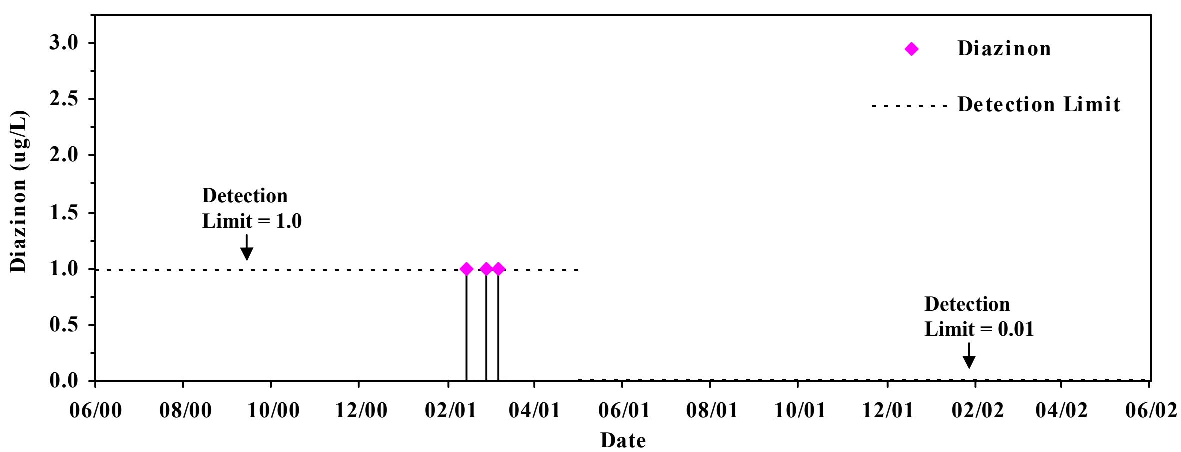

b)

Figure 8.18 Dominguez Pump Chemistry Results: a) Chlorpyrifos; b) Diazinon.

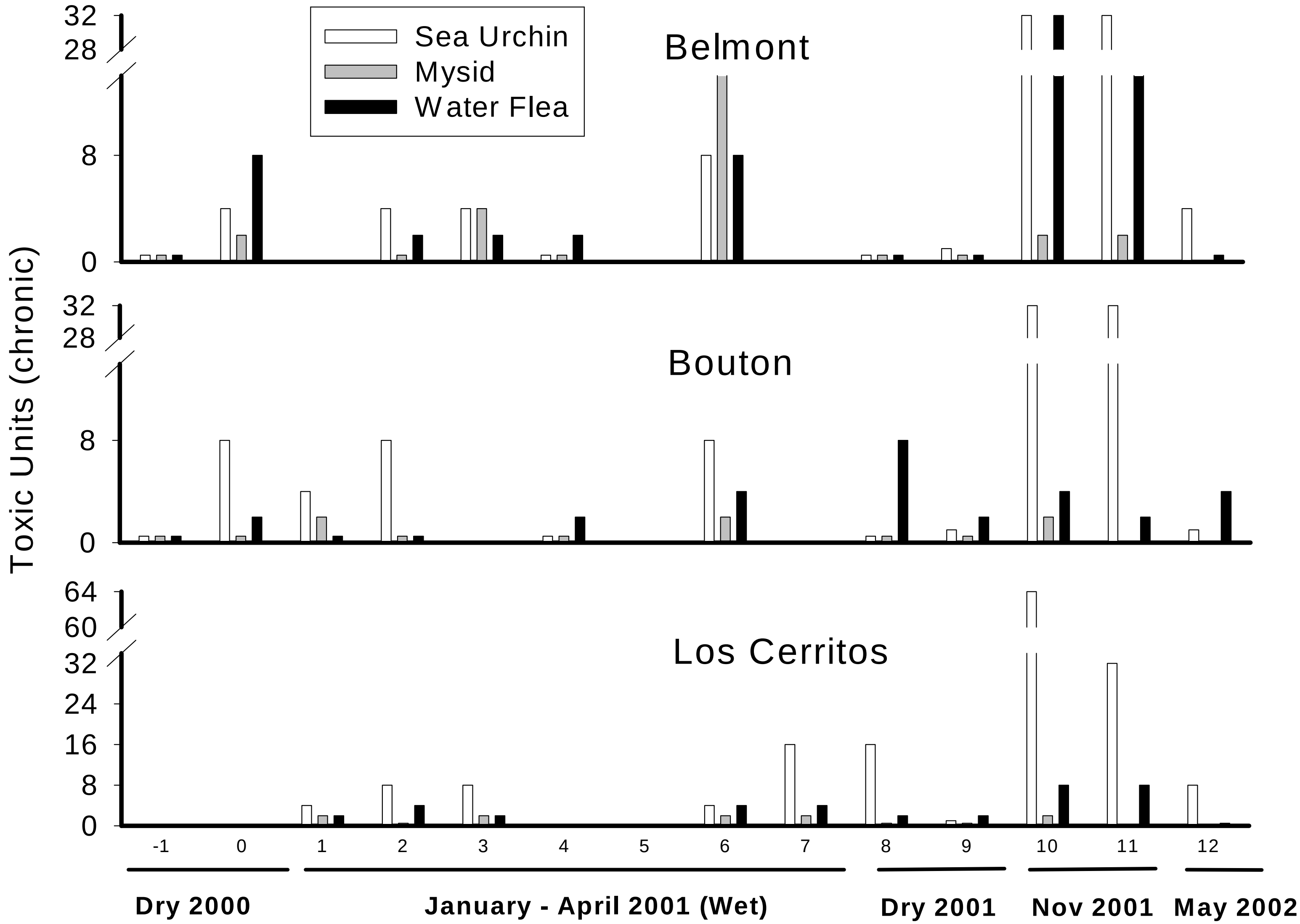

Figure 8.19. Summary of Wet and Dry Weather Toxicity Results for all Long Beach Samples.

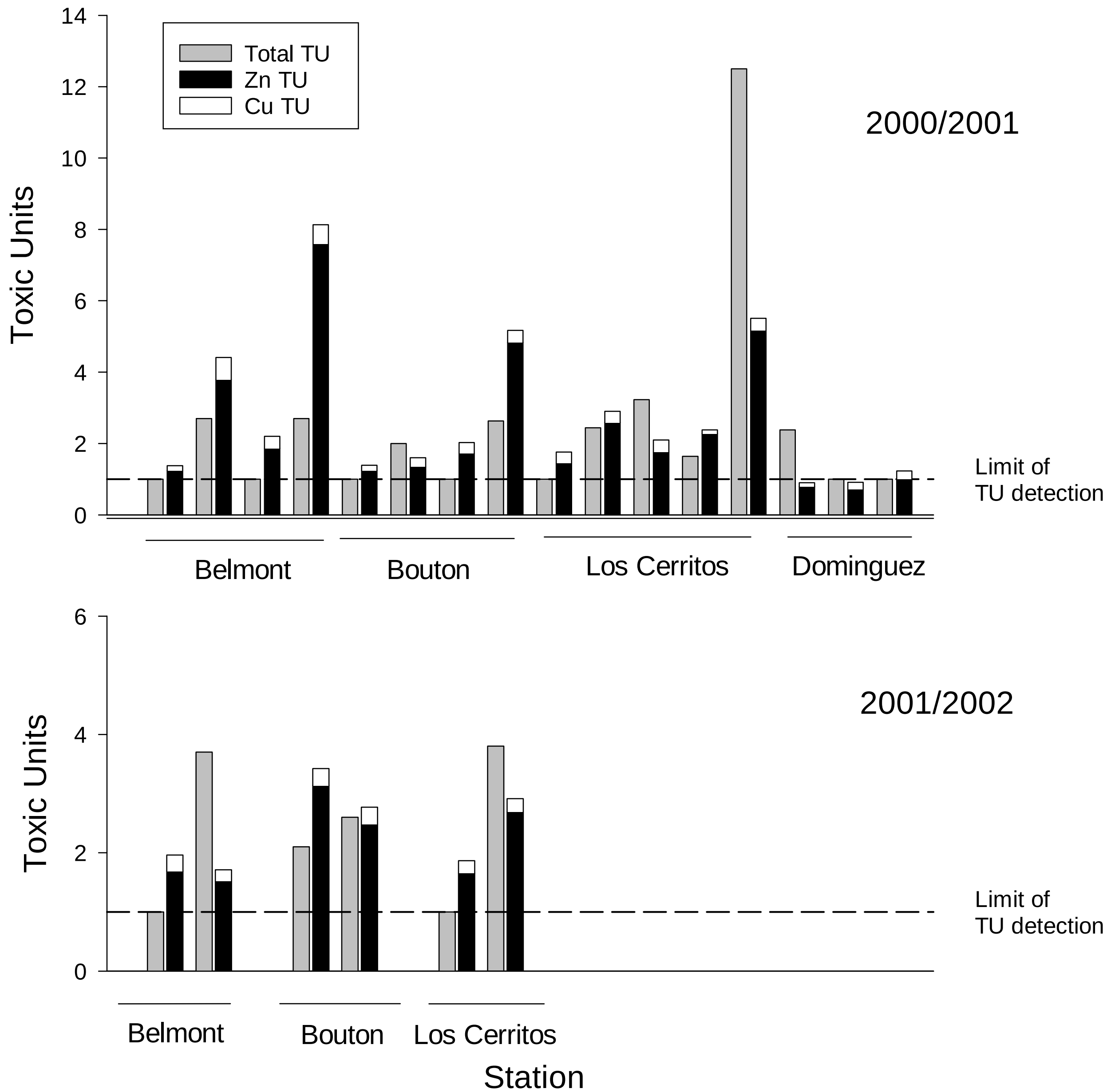

Figure 8.20. Comparison of Measured (Total) Toxic Units for the Sea Urchin Fertilization Test and Toxic Units Predicted from the Dissolved Concentrations of Copper and Zinc in the Test Samples. Measured toxic units are based on the EC50 (100/EC50). A value of 1 toxic unit was assigned to low/nontoxic samples having an estimated EC50 of >100%.

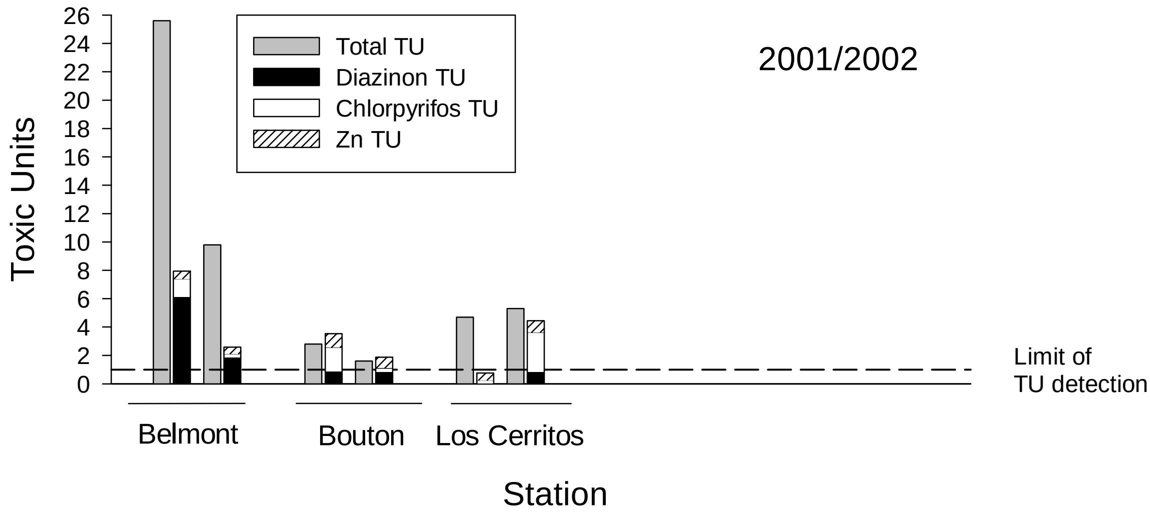

Figure 8.21. Comparison of Measured (Total) Toxic Units for the Water Flea Survival Test and Toxic Units Predicted from the Concentrations of Chlorpyrifos, Diazinon, and Dissolved Zinc in the Test Samples. Measured toxic units are based on the EC50 (100/EC50). A value of 1 toxic unit was assigned to low/nontoxic samples having an estimated EC50 of >100%.

9.0 CONCLUSIONS

Stormwater and dry weather monitoring has been carried out for the City of Long Beach at four mass emission stations and one receiving water station as specified in the NPDES permit. Twenty-one wet weather station events have been monitored along with twenty dry weather inspections/monitoring efforts. This program involved a coordinated chemical analysis and toxicity testing (marine and freshwater) approach.

Exceedances of provisional benchmark values have been identified for some metals, primarily zinc and copper, and for diazinon and chlorpyrifos (organophosphate pesticides). Stormwater discharges have consistently shown measured toxicity to freshwater and marine test species, but the one receiving water site (lower Alamitos Bay) does not show measured toxicity, consistent with indicated dilution. Bacterial levels in the wet weather discharges are 2 to 3 orders of magnitude above receiving water criteria and dry weather discharges also exceed criteria. Data from Alamitos Bay receiving waters and from the City of Long Beach Department of Health and Human Services show that the Bay bacterial values are elevated during rain events, but are at relatively low values during dry weather periods.

Toxicity Identification Evaluations (TIEs) implicate organophosphate pesticides (diazinon and chlorpyrifos) in causing toxicity to the freshwater water flea. In addition, dissolved metals, primarily zinc and perhaps copper, are implicated in the toxicity to the purple sea urchin (marine).

Proposed storm water monitoring program refinements/recommendations at this point in the program include the following:

- The Dominguez Gap Pump Station discharges infrequently to the Los Angeles River, only during periods of large and intense rains (3 events captured to date). Dry weather flows at this station are non-existent. It is recommended that the monitoring efforts and resources be directed elsewhere in the program.
- Additional TIE work needs to be conducted to verify the preliminary results on the causes of toxicity in Long Beach stormwater and dry weather flows.
- Considerations should be given to further receiving water sampling to measure chemical and toxicity impacts in the receiving waters. Establishing two receiving water stations in upper Alamitos Bay may help to evaluate if receiving water quality criteria are being impacted by stormwater discharges. This may be achieved by relocating the current lower Alamitos Bay receiving water site and redirecting resources currently expended at the Dominquez Gap site to establishment of a second receiving water location in upper Alamitos Bay.

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